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THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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THE WORKS NOW CONSTRUCTING AT THE MOUTH OF THE MISSISSIPPI.

It would be difficult to estimate the value of a permanent improvement in navigation from New Orleans to the Gulf of Mexico. To open a route here for vessels of the largest class would be to bring the Mississippi valley directly and fully before the grain and the mineral markets of Europe and Asia. It is hardly necessary to say that the great West becomes daily the more interested in such an object in proportion to the accumulation of her products, for which full seaboard transportation is so delayed.

Years ago, among the arguments for a ship-canal across our Isthmus, Lieut. Maury, with others, urged with effect this accumulation of the varied products of the Great Valley. He called attention to the fact that the areas of this great river and of others like it offered the products of different zones. "On the lower banks of the Mississippi," he said, "the harvests commence in June; on the upper, in November. There is here, then, a succession of crops through more than half the year; and at the mouths of these rivers commerce may gather the fruits of different climes, to seek which in the Old World she must visit all latitudes." At this day the illimitable and varied products of these zones of the great river above, call loudly for unobstructed access to the Gulf, and a canal thence across the American Isthmus would be virtually an extension of the Mississippi to the Pacific. A vessel might load at St. Louis and discharge cargo in California (especially if the Tehuantepec route should be adopted), with but little more risk than that of inland navigation.

An exchange, especially of the mineral treasures of the Great Valley westwardly for the riches of Asia, and eastwardly with Europe, must open a new era for the commerce of the West.

The improvement of navigation across the short strip of the Mississippi delta has long been the study of our engineers. Very able and extended reports on the hydraulics of the river have been made by Humphreys, Abbot, Howell, and others of the Army Engineer Corps. Within the last two years, under the approval of some of the ablest of this corps, the sanction of the Government has been extended to the project of Mr. James Eads for deepening one of the passes from New Orleans to the Gulf. The conditions of this work and its characteristic features are well worth attention.

Board of Survey.—Under the Act of Congress of 1874, Lieutenant-Colonels Alexander and Wright, Major Comstock, Mr. Henry Mitchell, of the Coast Survey, and others, were constituted by the Secretary of War a Board "to survey the mouth of the river and determine the best method of obtaining and *maintaining* a depth of water sufficient for the purposes of commerce, either by a canal from said river to the waters of the Gulf, or by deepening one or more of the natural outlets."

The report of the Board, with extended memoranda upon it, by General Humphreys, Chief of Engineers, occupies nearly forty pages of the latest report from his bureau. The Board states that as there was no instance in our own country of the improvement of a river mouth to give an outlet with much deeper water than exists on its bar, they found their only examples in the mouths of European rivers. They visited the improvements of the Vistula, the Danube, and the Rhone, as well as the works at the Amsterdam, Rotterdam, and the Suez Canal, before surveying the mouth of the Mississippi. Their instructions calling upon them to report on the construction of a ship-canal, and upon the plan of deepening one of the outlets, and to indicate a preference in these two plans, they submitted the following facts:

I. If a *ship-canal* were constructed, it should leave the river five and a half miles below Fort St. Philip, and should have a basin 1000x2500 feet, with the necessary guard-lock, the canal itself being about six and one-third miles in length, with a depth of 27 feet at mean low water, and the width of 200 feet. The lock would be 500 feet by 65—dimensions, it will be seen, in accordance with the present wants of commerce. The estimated cost of original construction, and of annual maintenance of such a canal, is set down at eleven and a half millions.

II. But on the inspection of the different outlets of the river mouth, the Board unanimously preferring the one known as the "South Pass," recommended its improvement by deepening, in preference to the construction of a canal. This outlet is $12\frac{9}{10}$ miles long, has already an average width of 730 feet, and the minimum interior channel-depth of 29 feet. It discharges at its mouth about 57,000 cubic feet of water per second, and about 22,000,000 cubic yards of sediment in suspension per annum.

III. For the improvement of this pass, and securing through it a permanent depth of water, they recommended the construction of parallel jetties, or dykes of fascine or willow mattrass-work, in the same general way as those used by Mr. Caland, at the mouth of the Maas, for the new navigation from Rotterdam. The constructions of parallel groynes, it is well known, by confining a river in its shallow sections, effect a scour which itself washes out a depth for the channel. One of the most noted instances of their success familiar to all engineers is found on the Clyde, a river fordable just below Glasgow in the last century, but now enriching the city with the commerce of the largest vessels.

Peculiarities of Fascine Work.—The use of fascine work in the construction of such jetties is, we believe, employed for the first time in our country in these improvements of the Mississippi mouth. It has long been in use in Holland and the more northern countries of Europe. Formerly applied to their interior works only, within late years it has been used also on their coasts. The experiment at the mouth of the Maas, for the benefit of Rotterdam, was reported by the U. S. Consul, Mr. Schutz, as successfully finished in July last, when the steamer "Maas," drawing fifty-two decimetres ($20\frac{1}{2}$ feet), first passed through the new channel of the Hoek, with her cargo and all her coal for New York.

Section of Jetties at outer End.
Low Water (0)
Intermediate Section of Jetties
Low Water (0)
Section of Jetties at upper End
Low Water (0)

Sections of Jetties for South Pass, Mississippi River, as prepared by the Board of Engineers, 1873.

A detailed account of the construction of this fascine work will be found in General Barnard's report of the North Sea Canal (Professional Papers, Corps of Engineers, No. 22) and a separate valuable paper on the same subject appears in the Minutes of the Institution of Civil Engineers (Vol. XLI, part iii). The following brief extract from the latter of these papers will explain this novel construction:

"The mattrass is made on shore, near the jetty, between high and low water, and when constructed is floated to its destination and fastened by anchors and ropes. Then the ballast-stones, weighing, on an average, one hundred and twenty pounds each, are deposited on it from small vessels surrounding the mattrass, first over the middle and afterwards over the general surface, till the mattrass is immersed. The sinking lines, with which the vessels are attached to the mattrass, are thereupon paid out, and at last detached; and in the meantime still more ballast is cast on the mattrass. Generally about 5 cwt. 1 qr. of stone per cubic yard will suffice to bring it aground, but at the north jetty 10 cwt. 2 qrs. of stone are charged per cubic yard of mattrass, to oppose greater security against the shock of the waves.

"When the fascine work of the jetty is raised above low water, oak piles are driven through into the bottom in rows reaching six feet seven inches above the water line. Rows of piles are also driven through all the layers under the track of the rails laid for the conveyance of stone and other material. Elsewhere the rows of piles are shorter, and only serve to secure the stone revetment."

Between the rows of piles, around the jetty forming the fore-berme, and outside this berme, stones weighing, on an average, nearly ten hundred weight each, are placed. Above low-water level the jetty is formed of osier layers ten inches thick, secured by hurdles nearly two feet apart. The space between these hurdles is filled up to their top with rubbish or waste stone. The entire top of the jetty must be covered with stones weighing, on an average, one hundred each.

In order to get well-connected joints, stones of a more regular form are employed for this pavement. Experience has proved the stability of this mode of construction, heavy storms and strong currents not being able to damage the jetties. When the bottom, along the head and sides, is deepened, those parts of the mattrasses protruding from the jetties will, by their flexibility, follow the inequalities of the bottom, and shelter the works from undermining. The theory of this system of breakwater is—

First.—That being to a certain degree elastic, the shocks from waves produce less injury than on a divided mass (as blocks, for instance) perfectly rigid.

Secondly.—That in a short time the internal interstices will be completely closed with sand, while the exposed surfaces will be coated, and, so to speak, agglomerated, with sea-shells, weed, etc., so as to form, eventually, a solid mass, and at the same time protect the interior work from decay and the attack of worms.

ANNUAL EXTENSION OF JETTIES:—The plan of the works at the mouth of the Mississippi includes, as a necessary feature, the annual extension of the jetties of fascines and stone for the term at least of three years. The estimates are—

First cost of jetties, dredging, etc., ...	$5,342,110
Average annual cost of extension, etc., $130,000, which, capitalized at 5 per cent., adds	2,600,000
Total	$7,942,110

On the score of cost, the difference in favor of this plan over the construction of a canal is more than $3,000,000; on other grounds, also, the preference is given for the improvement of the South Pass. Success there will give a good sea entrance of 900 feet in width, with a minimum width, within the Pass, of 530 feet. The width of the canal would not exceed 300 feet, and its locks are of course objectionable on the ground of delays to navigation and liability to injury. It is proper, however, here to note that this preference was not concurred in by the president of the Board, Col. Wright. We find that while agreeing to the correctness of the plans and estimates, and in the selection of the South Pass, he does not expect that an adequate and permanent channel can be maintained through any one of the outlets. In this opinion General Humphreys seems also to concur in the extended memoranda on the report of the Board, in which he gives at length the unsuccessful experience of the jetty system, abandoned at the mouth of the Rhone after ten years' effort. A ship-canal in place of it was opened there in 1871.

APPROPRIATIONS BY CONGRESS.—For Mr. Eads' plans a conditional appropriation was made in the "River and Harbor Act" of 1875, by which he and his associates are to receive instalments of a total of $5,250,000, these instalments being payable on the official reports of Engineer Boards from time to time, that he has secured a channel increasing in depth from 20 feet to 30 feet, and in width from 200 feet to 350 feet. If successful in their work they are to receive annually $100,000 for thirty years thereafter, in quarterly annual payments, conditioned on maintaining the full depth and width named. He has also the legal right to use under the regulations of the Secretary of War, any materials on the public lands which may be suitable for, or needed in, the construction of the works.

PRESENT CONDITION OF THE IMPROVEMENTS.—As regards the progress of this important project, the only official reports which have as yet seen the light, are a letter from Mr. Eads to the Secretary of War, dated June 26th, and a report of Major Comstock, Corps of Engineers, in charge for the War Department. Mr. Eads informs the Secretary that on the 14th of June he commenced the construction of the works at the bar of the South Pass; that the contractors, Andrews & Co., had extended the provisional works for the building of the east jetty 1,000 feet from the land's-end, and were pushing them forward at the rate of 200 feet per day. On the 5th of October General Comstock reports in substance as follows: On the east side of the Pass, about 1,100 piles had been driven in a line nearly parallel to the direction of the Pass, extending to a distance of 11,934 feet. Parallel to the greater part of this line, a second row of piles had also been driven, and a single layer of mattrasses had been placed, with its edge against the channel-side of this second row as far as it extends, and beyond that against the first row. These mattrasses have varied from 75 to 100 feet in length, from 40 to 50 feet in width, and from 2 to 2½ feet in thickness. They are made of willows from two inches to a quarter of an inch in diameter at the butt; are built on ways, and pulled from the ways into the river by a tug. The mattrasses are towed from the ways to their places against the line of piles and tied to them, being usually allowed to sink by absorbing water, and, after sinking, a few stones have been put on some of them. More recently, sand has been pumped on some, to sink them more rapidly.

The west jetty, at the same date named above, had received a row of piles extending to a distance over 3,000 feet. The contractors having had much difficulty in obtaining willows fast enough to carry on their work, had used, in a number of cases, the tall reeds growing in that region, to finish their mattrasses.

We have here presented the essential features of this important project. The opinions of our engineers are still somewhat divided as to its ultimate success, some of our ablest men being as sanguine, as others are cautious, in regard to it. It will be remembered that during the past summer Sir Charles Hartley, distinguished recently in connection with the improvements by jetties at the Sulina mouth of the Danube, was one of a consulting board in New York, with General Barnard, U. S. A., on the subject of these improvements. The greatest interest must continue to await further developments of success.

J. E. N.

THE LOWE ILLUMINATING GAS PROCESS.

To attempt even a superficial sketch of the multitude of processes and devices, upon which patents have been obtained for presumable improvements in the production of illuminating gas, would fill a volume of respectable dimensions. Our purpose here, however, is not to inflict upon our readers a lengthy historical *resumé*, the prominent feature of which, unfortunately, would be the resurrection of the failures and shattered hopes of a host of inventors, but the more pleasant one of recording the nature and details of a recently invented process of this kind, the performance of which on a commercial scale has achieved for it the title of a veritable improvement.

A large proportion of the failures just alluded to, comprise those in which what is popularly known as *water-gas* plays a prominent part; or to put it differently, they comprise the attempts that have been made to manufacture an illuminating gas by the decomposition of water, and the simultaneous or subsequent carburation or enrichment of the product, by the use of various solid or liquid hydro-carbons. The improvement above referred to is known as the "Lowe Gas Process," the invention of Mr. T. S. C. Lowe, of Norristown, Pa., and inasmuch as it is a "water-gas" process, it is worthy of more than passing attention on the part of all who are interested in the economical production of gas for heating and illuminating purposes. In general terms, the Lowe process may be defined as a method of making illuminating gas from carbon, steam and petroleum. The first step of the process is the production of "water-gas," which is effected by the contact of steam with carbon (in this case anthracite coal) heated to bright incandescence. The second step consists in combining the mixed hydrogen and carbonic-oxide gases produced in this manner with the richly carburetted gases of petroleum, whereby the resultant product is rendered luminous. The third step involves the manipulation (i. e. washing, purification, &c.) of the completed product, in a manner analogous to that employed in the ordinary coal-gas works.

The apparatus for producing the water-gas, which an eminent authority in such matters* has designated as extremely compact and efficient, and occupying very small ground space, consists [see engraving] of the generator (*a*) and the superheater, the dimensions of which will vary according to circumstances. The functions of these devices will appear from what follows: The generator is first charged with clean anthracite to the depth, say, of three and a-half to four feet, broken to rather large egg size, the charging being effected through the manhole (*p*) at the top. The charge is then ignited and blown up to a state of intense incandescence by a blast of air entering under the grate (*g*). The combustion products, consisting of carbonic-oxide and nitrogen, pass from the generator downwards by a suitable pipe (*f*) into the base (*g*) of the superheater, where they meet with a fresh blast of air, which causes them again to kindle, and drives the flame upwards into the superheater and through the loose mass of fire-bricks with which it is partly filled. The burnt gases pass up the chimney through a valve (*h*) in the top of the superheating chamber. The joint effect of the operations here described is such, that by the time the anthracite in the generator is heated throughout its mass to bright redness, the body of fire brick in the superheater will be nearly or quite white-hot. When this condition of things is reached, the air-blast is shut off, the valve (*h*) at top of superheater (controlling the passage to the smoke-stack) is closed, and the outlet (*n*) leading from the superheater to the washer, purifier, &c., is opened. A current of hot steam is then led into the incandescent coal, through a suitable pipe introduced at the base of the generator, while crude petroleum, led through trapped pipes, is dropped simultaneously from above on the glowing surface of the coals. The resulting mixed gases and vapors pass from the generator into the superheater and through the mass of intensely heated fire-bricks (by contact therewith being so changed as to have acquired a permanent character), and thence pass on, through the outlet (*n*) of superheater, to the washer, purifier, &c., to the gas-holder, in the manner usually employed in the coal-gas works.

The practical reader, in following us through the above description, must be struck with the eminent simplicity and compactness of the apparatus peculiar to this process; while of its efficiency and economy as a producer of illuminating gas of high quality and great permanence and uniformity, recent careful investigations of the process and product at Utica, N. Y., where works of this description have lately been started, by no less an authority than Professor Henry Wurtz, leave us no room for doubt. The most reliable estimate of the practical merits of the Lowe process may be made from the facts and figures gathered by this eminent gas chemist, whose conclusions we deem to be of such exceptional interest that we append them herewith.

[For complete details of Professor Wurtz' examination of this subject, our readers are referred to a "Report upon the Lowe Process of making Illuminating Gas from Carbon, Steam and Petroleum," which appeared in our esteemed contemporary "*The Engineering and Mining Journal*," of November 20th, 1875, p. 502, *et seq.*]

After explaining the construction of the apparatus and its *modus operandi*, and the results of his experimental chemical and physical tests of the product, Professor W. announces the following general conclusions:

1. The Lowe process, as operated on an ample working scale—120,000 cubic feet per day—at Utica, constitutes an exceedingly *compact* and *efficient* apparatus, occupying very small ground-space, for evolving water-gas from anthracite coal and steam with surprising rapidity.

2. The average amount of *carbonic acid* in the completed illuminating gas, is reduced by this method to three and a-half per cent., a proportion readily manageable by ordinary lime purification.

* Professor Henry Wurtz.

3. The practical result is a complete and reliable *uniformity of quality* of the gas for weeks together, quite comparable with that obtained in a well-regulated ordinary coal-gas works.

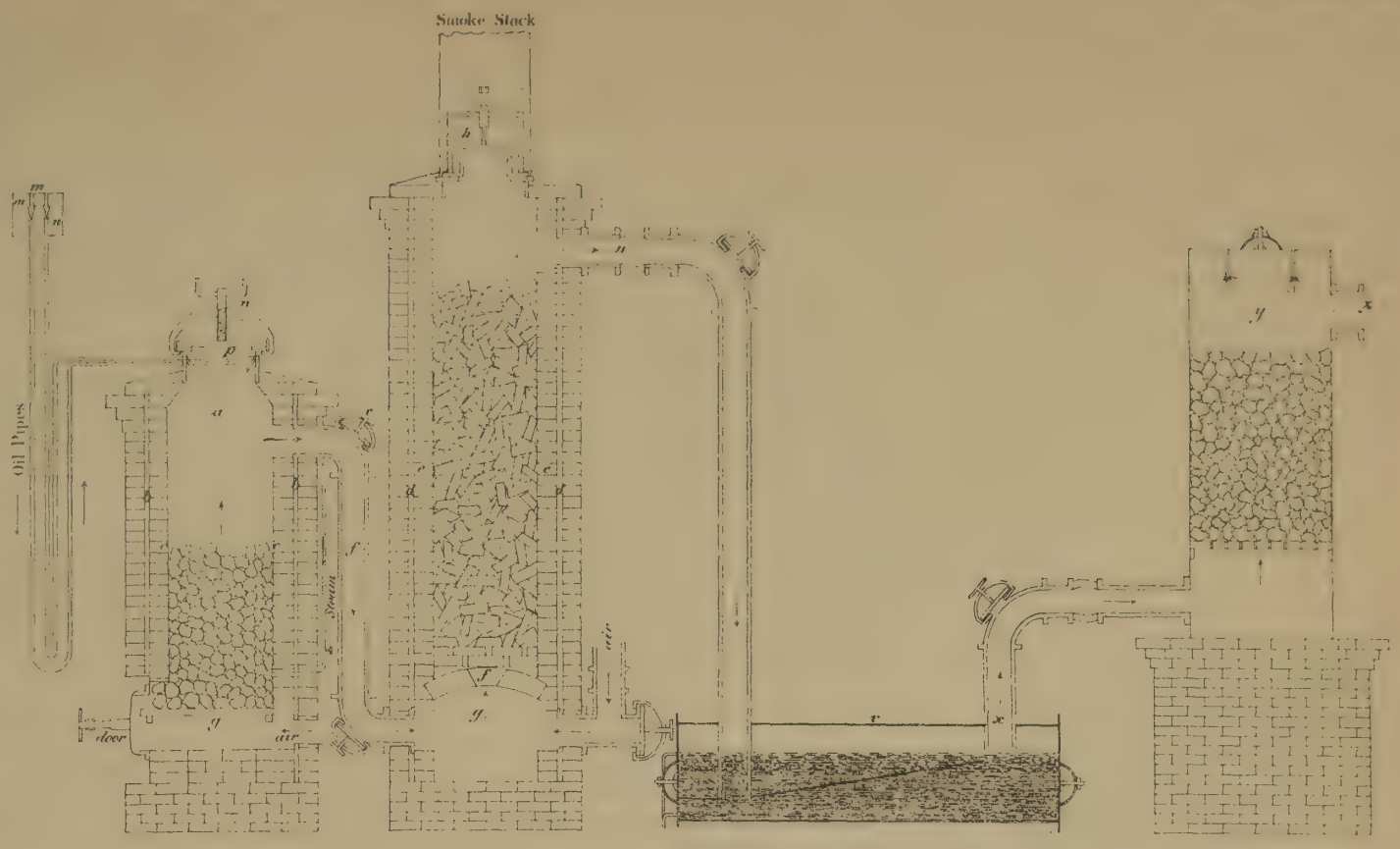
4. The amount of *gas-tar* produced per thousand feet of finished gas, is but one-fourth of that from gas-coal.

5. The amount of sulphur in the finished gas is but *one-third* of that from a first-class gas-coal, and hence, notwithstanding the large proportion of carbonic acid, complete purification with lime is not more troublesome or more costly than in the case of a good gas-coal, one bushel of slaked lime purifying about 5000 cubic feet of gas.

6. The amount of ammonia is but one-fifth of that in coal-gas, and hence the fouled lime from the purifier is very much less offensive and troublesome than in the case of coal-gas.

7. The amount of naphthaline is small, and cannot, with proper tar-condensation, give rise to any trouble.

8. Enrichment with about three gallons of petroleum to the thousand feet of gas, furnishes, by this method, a perfectly permanent gas of between nineteen and twenty candle-power, and it is probable that if the tar-condensation can be effected without contact with cold water, a somewhat less proportion of oil may give the same illuminating value.



SECTIONAL VIEW OF LOWE'S IMPROVED GAS WORKS.

9. The current cost of nineteen and a-half candle gas delivered into the holder, inclusive of all labor and materials (not inclusive, however, of interest, salaries, taxes, repairs, etc.), is admitted to involve a saving of at least thirty-five per cent. over that of gas from gas-coal, of a much inferior quality and smaller actual money value to the consumer.

10. The density of this nineteen to twenty candle gas was not above .571, comparing favorably with that of some cannel gases of but little higher candle-power.

11. So far as could be judged, from the absence of testimony to any poisonous or morbific action of this gas, at least upon men in good health, the objections to water gas on this score would appear to have been much exaggerated.

12. I must finally sum up, by expressing with emphasis the gratification with which I have recognized the solid progress that is made by this successful process, in realizing what I have long awaited as a real step in the arts of civilization—the cheap manufacture of combustible gas from carbon and steam.

The following statement, for the month of October, of gas made and materials used by the Utica (N. Y.) Gas Company, using the Lowe process, will be useful in connection with the remarks that have preceded:

Anthracite coal (tons),	123½
Crude petroleum (gallons),	11,753
Gas made (cubic feet),	3,745,200
Candle-power, by jet photometer,	19

Labor two men, day and night. (i. e. two on each shift.)

From the foregoing our readers can draw their own inferences concerning the practicability of the process as a commercial operation.

We may remark, in conclusion, that while we are disposed, on general principles, to aid, promote and encourage improvements in the useful arts, there is no field of invention in which real progress will be more gladly welcomed, or be productive of more direct and wide-spread benefits, than the improvement of the ways and means of illumination. What the Lowe process has accomplished may be concisely summed up in the statement that it has successfully solved one of the most perplexing problems in the practical chemistry of gas making, and one that has been a veritable *ignis fatuus* to a generation of inventors, namely, to employ the non-illuminating but combustible gases produced from the decomposition of water by contact of its vapors with red-hot carbon, so as to give them, when united with hydro-carbon gases and vapors, "an average illuminating power and permanency, which shall make the joint product an equivalent in illuminating power to the best coal-gas, while securing also, from the same materials, a largely increased volume of gas at a nominal increase in cost; or, what is the same thing, to obtain a given volume of gas of a certain candle-power at an important reduction of cost." *

METRIC SYSTEM OF WEIGHTS AND MEASURES.

The appended considerations contain the essential portions of a document issued by the "Boston Society of Civil Engineers," with the avowed object of securing the united action of all organizations throughout the country in petitioning Congress to fix a date after which the metrical weights and measures shall be adopted as the legal standard. The action of the Boston Society in thus taking the initiative step towards effecting a reform that is as desirable as it is inevitable of accomplishment, indicates not only a proper comprehension of the importance of the subject, but also a praiseworthy independence of a powerful "outside influence," which, from interested motives, has arrayed itself in opposition to what the ablest minds of our times have agreed to call a real advance in civilization.

"In view of the amazing increase of international communication during the last half century, it is evident that in making any reform in weights and measures steps should be taken towards uniformity with foreign countries. There does not appear to be any movement among other nations towards the adoption of our yard, pound, and gallon; nor among the English-speaking people themselves are we aware of any active efforts to make them more convenient. The European nations, however, with the exception of England, Norway, Sweden, Russia, and Turkey, may fairly be said to have united upon the metric system, which has also been adopted by our neighbors in Mexico and South America. It has for some years been legalized in the United States and in Great Britain, and the latter has adopted the meter gauge in the construction of some of the India State railways. Even Turkey has made its archine equal 75 centimeters. An international convention, in which more than twenty nations were represented, has prepared standard meter bars, and distributed them among the several countries taking part. The greatest precautions were used to insure accuracy, and a permanent bureau has been established to make any comparisons that may be needed in the future for maintaining uniformity. If we appreciate the advantages, therefore, of having one system throughout the civilized world, our first work is to adopt the metric, even if we do not believe that that is the best which will ever be devised. If we should refuse to join in what has already received the approval of the majority of nations, we should not be in favorable position, a generation or more hence, for urging the rest of the world to aid us in any further improvement.

"The decimal subdivision of the meter is sometimes objected to as not being so simple as binary division would be; although it appears to us that halves and quarters of the meter might be used as freely as halves and quarters of a dollar are; in fact, its decimal character is one of the very greatest recommendations of the metric system (at least, so long as decimal notation prevails in arithmetic, and this can hardly be changed for a century to come). That decimal division of weights, measures, and money is of the first importance in computation is shown by the praise generally bestowed on the federal currency. It is on account of this advantage that engineers use decimals of a foot where they can, although in doing so they are at variance with the practice of the rest of the community.

"The opinion is also expressed that the meter is not a convenient length for a standard. For some uses it may not be; for others it evidently is. No one standard could be expected to be perfectly adapted to all purposes. We must have several units, appropriate to different classes of measurement; and it is the merit of the metric system that its secondary units have the simplest of relations to one another. In the laboratory the millimeter may be the unit, in the machine-shop the centimeter, and on a railroad line the meter and the kilometer; but we can translate quantities from one to another by moving the decimal point; whereas quite a mathematical computation is required to reduce inches to feet, rods, and miles.

"The real difficulty, we believe, is not with the proposed system, but with making the change. The cost of such a revolution, affecting so large a proportion of the transactions of life, will obviously be enormous; but it is equally true, if not quite so obvious, that it is costing us enormously to keep up the present confusion. The army of custom-house clerks employed in making transfers from one kind of weight or measure to another bears witness to one item of expense. The time thrown away in our schools in teaching innocent children that $7\frac{92}{100}$ inches make a link—a fact that surveyors have all but forgotten—is sad to think of and to pay for. Nearly every individual in his daily business has to undertake brain labor in dealing with our present irregular weights and measures, which could be saved by the use of a simpler system. It would be difficult to estimate, in money, the value of this work; but for our whole population it would amount, in a long series of years, to an immense sum, to say nothing of the vexation and the probability of being cheated.

"Whether we like it or not, there are many indications that our people will at no distant day adopt the metric system. It is already used in the Mint and on the Coast Survey. Men of science have used it for many years. It is used by analytical chemists, and a great many architects in our principal cities have indicated their opinion by agreeing that they will use it after next Fourth of July. The subject is constantly agitated by the public prints and by the discussions of various societies. The system is taught in

our schools and colleges, and is imported with our merchants' goods and our foreign books; so that there are already many individuals among us who appreciate its advantages. One of the commonest remarks that we hear is that its adoption is only a question of time. If that is the case the sturdiest opponent must admit that nothing is to be gained by postponement. As far as he is concerned, the older he grows the harder he will find it to change.

"The question before us, therefore, we understand to be, Shall we endeavor to bring about the change with as little inconvenience as possible, by studying the matter in advance and making careful preparations, or shall we wait to be driven into it by forces beyond our control?

"To accomplish the result economically, it is obviously necessary to have concerted action throughout the community. Different classes of business are so related that they cannot be conducted independently of one another. Engineers, for instance, are not likely to make the change without the concurrent action of the manufacturers and contractors who furnish materials and execute their plans. Among the members of any one class, moreover, there is wanted the confident assurance of universal action. A mere majority might well hesitate to undertake a very expensive change, sure to be distasteful to some of their patrons, if a minority of competitors in the same business were left free to continue indefinitely in the old way.

"*With a powerful public sentiment in favor of the reform, it will still be desirable that some controlling voice should give the signal for a simultaneous movement toward the actual abondonment of the present measures and substitution of the new ones.* That may evidently be done by Congress setting a time when the change must be made; and our business men are apt to say that this is the only way in which the change can be made. We suppose that eventually the metric system will be established as the law of the land; but that people will not make effective preparations for adopting it until Congress shall appoint some day in the future for such legislation to take effect. Congress may be expected so to fix a date, if it can be convinced that public opinion will abundantly support it. To this end it is hoped that influential bodies throughout the United States, who are ready to welcome the change, will not fail to make their feeling known. We suggest that the appropriate form in which to express it is an appeal to Congress for compulsory legislation, for this seems to furnish the key to the whole situation. Let the main attack be concentrated upon this point, though a rattling fire of efforts elsewhere may be of great service.

"When people know exactly how much time they have before them, every one will readily decide, with reference to his own transactions, upon the successive steps by which the new measures can be gradually introduced and familiarized, and the present ones abandoned. Memorials have been presented to Congress by the American Metrological Society, pointing out what changes towards the metric system appear to be next in order in the management of the government business.

"That the numerous and very great obstacles in the way of this reform can be surmounted by conducting it in a deliberate and judicious way is proved by the history of the recent adoption of the metric system in Germany. It is a most encouraging fact that a country so densely inhabited, standing so high in the scale of civilization, and having all the arts, manufactures and commerce so fully developed, should have been able in the space of four years to effect the adoption, in nearly all the affairs of life, of a new system of weights and measures. The movement was begun there by societies of civil engineers, architects, railroad superintendents, foresters and agriculturists, naturalists, chemists, and others, who passed votes and sent petitions to the German Congress to have some uniform and sensible system of weights and measures made the only legal standard in Germany. After some years this induced the appointment of an expert commission, which reported in favor of the metric system, and recommended immediate legislation. Accordingly, in 1868, the German government passed a law which made the new measures the only legal standard from and after Jan. 1, 1872. The expert commission was kept in existence, and made to superintend the innumerable details of the change. During the intervening time the greatest activity prevailed throughout Germany in making preparations, so that on Jan. 1, 1872, there was but little left to do. The principal changes had already been gradually effected, and what was left to be done was of slight relative importance, and was accomplished with very little disturbance to business. Let us profit by this example."

The document closes with the following memorial to Congress, which is offered with the expressed hope that other societies may be induced to aid in the work, by presenting to Congress petitions of similar purport, viz.:

"*To the Hon. the Senate and the House of Representatives of the United States, in Congress assembled:*

"The memorial of the Boston Society of Civil Engineers respectfully showeth:

"That the weights and measures now generally used in this country do not have simple relations to one another, are ambiguously named, and are inconvenient in computation; and that it is expected that they will be gradually abandoned, and that the only legal standards will be those of the metric system, which has been adopted by most foreign nations, has decimal subdivision like the federal coinage, and possesses other advantages.

"That, in anticipation of this result, it was enacted by the Congress of the United Stases, in 1866, that the metric weights and measures *might* be used in all business transactions.

"That, nevertheless, the members of the above-named society, and others, find it impracticable to avail themselves of the benefits of this permissive legislation by actual changes in the conduct of their business, for the reason that each and every class or profession is in such close relations with other classes in the community that in this far-reaching reform it is impossible for any one of them to act independently of the rest, or to foretell when others will be ready to coöperate.

"That they would welcome legislation which should result in a harmonious movement among all the people, every one knowing when to take the successive steps of change, and confidently relying upon the action of others at a time to combine economically with his own efforts.

"The prayer of your memorialist, therefore, is that your honorable body may enact that, after some date, to be fixed several years in advance, the metric standards in the Office of Weights and Measures at Washington shall be the sole authorized public standards of weights and measures.

"And your memorialist, as in duty bound, will ever pray, etc."

MILK AND WATER AS CARRIERS OF DISEASE.

Since Dr. Ballard, of Lower Sedgely, England, first made his investigations into the cause of a severe epidemic of typhoid fever in Islington, in 1870, which resulted in the discovery that one-half of the families who were supplied with milk from a particular dairy were invaded by the disease, that in these families only those who drank this milk were attacked, that all who were the first victims in other families or localities had partaken of it, and finally that the milk-vendor himself and seven other persons living on the premises had the fever; since, I say, this unmistakable train of causation in this instance was so clearly followed up, we have had numerous similar cases brought to light. Dr. E. W. Gray affirms that "subsequent investigation into the nature of contagious and infectious diseases confirms the views intimated by Dr. Ballard. Such is the nature of the typhoid contagion that the smallest particle taken from a breath of air or a drop of water will, under suitable conditions, so multiply and increase as not only to prostrate and destroy the strongest organism, but, distributed as it may be, to become a devastating epidemic capable of destroying thousands, and filling the land with consternation."

But milk is also extremely susceptible to the influence of contagion floating in the atmosphere. Typhoid fever has frequently been carried in this vehicle when it had been exposed to the air of an infected house. Prof. O. Bell, of St. Andrews, Dr. Robinson, of Leeds, and Mr. Franklyn, in his work on *Milk Analysis*, all record cases in which milk was proven to have been the medium of conveyance of scarlet fever.

It cannot, therefore, be too strongly impressed upon farmers and dairymen that their dairies should never, under any circumstances, be contained in, or contiguous to, their dwelling-houses; that no one should be allowed to milk or take any part in dairy work, who is convalescent from fever or other infectious disease, until full six weeks have elapsed from the height of the disease; that all dairy utensils should be scalded out after using, and that only the purest spring-water should be employed for this purpose. To the traditional scrupulous cleanliness of the old-time Pennsylvania housewife is due the widespread fame of Philadelphia for the excellence of its dairy products, and it may be, too, in some measure, its comparatively low rate of mortality. Should we be so fortunate as to prevail upon our Legislature to create a State Board of Health, the condition of dairies and of the cars on which milk is transported over our railroads, should be one of their first objects of consideration.

Important as it is that our communities, especially the infantile portion of them, should be furnished with pure milk, this question dwindles into insignificance when compared with that of a pure water supply. And in this connection I desire to correct what I believe to be a very prevalent misconception on the part of persons living in the country, physicians as well as laymen. They appear to consider *clearness* of water a proof of *purity*, and point with pride to the sparkling fluid which graces their tables in contrast with the turbid beverage which those who depend on rivers are often compelled to drink. Now, although as a mere matter of taste, we would all undoubtedly prefer to take our water "straight," yet the admixture of a little mud does not necessarily make it unwholesome, while, on the other hand, there is such a thing as a water that is too clear. The presence of carbonic acid adds to the refractive power of this liquid, giving it a wonderful beauty and sparkle, most seductive to the eye, and yet it may be the result of the decomposition of animal matter, and only the index of a lurking poison. At a meeting of the Philadelphia County Medical Society, last winter, the question was asked, Why is it that typhoid fever is usually so fatal in the country and so tractable in the city? No one questioned the fact. I had no hesitation in attributing the difference to the greater impurity of much of the water that is drank in the country. The sole consideration of the farmer in sinking his well is, as a rule, convenience. He does not pause to consider the position of his cess-pool, dung-piles, and house-drains, the lay of the land and the dip of the geological strata, and then place it where he feels certain that no contamination from any of these sources can reach it; and the consequence of this disregard of a reasonable precaution is, that in more instances than any one imagines, such contamination does gradually find its way into it, and deadly disease is the result. People in the country, therefore, while the majority of them are blessed with a purer water than any one in such a city as Philadelphia can obtain, do yet not infrequently use a vastly more impure water than any one in Philadelphia is obliged to drink.—*Dr. Benjamin Lee—Report on Hygiene.*

NEW EMERY WHEEL DRESSER.

This is designed as a cheap and simple substitute for expensive diamond tools. It is claimed to turn or dress Emery Wheels in perfect running balance, leaving them clean and sharp, and to remove all dirt or glazing almost instantly. The handle and head are in one piece, having two sets of claws to hook over the inner edge of the "rest," so as to be instantly adjusted in its cutting position, should the rest be near to, or far from, the wheel. The head is provided with a series of independent sharp-toothed cutters, loosely

journalled on a revolving steel pin, in such a way that while they rapidly cut the emery wheel, they are not perceptibly worn by it.

Three cutters compose a working set; the two outside ones having teeth of the same size, the middle one being either coarse or finer. Thin steel washers put between the cutters and the inner sides of the tool head, give freedom of motion.

One set of cutters is claimed to do as much service as a diamond tool or carbon point, and may be replaced for a few cents. [C. Van Haagen & Co., Philadelphia.]

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GOOD ROADS more than pay, in time, horse-feed, and doctors' fees, and wheelwrights' bills.

MANUFACTURERS and dealers should encourage their employés, *now*, to learn German, French, and other foreign languages, in view of the coming influx of foreign customers.

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DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH. D., ROBERT GRIMSHAW, PH. D., } EDITORS AND PROPRIETORS.

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PROSPECTUS.

In inaugurating a new enterprise of this nature, it is customary for those having it in charge to prepare the way for its formal introduction to the public, by publishing a brief outline of the field of journalism which it proposes to occupy.

Having in mind the requirements of this custom, the managers of the "POLYTECHNIC REVIEW" have endeavored, in the title by which they have chosen to designate their enterprise, to anticipate public inquiry most fully and explicitly. It is their intention to make their publication in all respects what its name indicates—*a polytechnic review*: in other words, a journal devoted, in the widest sense of those terms, to the progress of science as applied to the useful arts.

The "Polytechnic" character of their journal they propose to maintain by the publication in its columns of original and selected articles—illustrated wherever appropriate or needful—descriptive and representative of current progress in

CIVIL, MECHANICAL, NAVAL, MILITARY and SANITARY ENGINEERING; GAS and WATER SUPPLY and SEWERAGE; CHEMICAL TECHNOLOGY, with particular reference to MINING, METALLURGY and the MANUFACTURING CHEMICAL INDUSTRIES; MANUFACTURES in general, and the MECHANIC ARTS.

The "Review" feature it is proposed to maintain, by publishing with every issue an abstract of such articles and items from the contents of the home and foreign scientific magazines, journals and newspapers, as well as a survey of such new improvements, inventions and patents, as are esteemed to be of interest or value; thus making the "POLYTECHNIC REVIEW" a *vade mecum*, embracing within its pages all the current news of interest in the field of applied science.

The managers of the "POLYTECHNIC REVIEW" enter upon their undertaking with warm encouragement and the most flattering assurances of active assistance from professional and practical celebrities. And now, having made their assurances and recapitulated in brief the scope of their efforts, they commend the enterprise to public favor, knowing that their achievements will speak louder than words, and with the declaration that they will spare neither pains nor labor to make the "POLYTECHNIC REVIEW" a reputable, widely-circulated and successful journal.

PHILADELPHIA, *January*, 1876.

MODERN FIRE ENGINES.

Fire proves itself on the one hand so good a servant, on the other so cruel a master, that it is no wonder that while inventors of one class study carefully how this power as a servant may be made available in the best, cheapest and safest manner, others should seek the quickest, most effectual and most economical manner of preventing or controlling its ravages. The prevention of destructive fires is of more importance than their extinguishment; but it can never, even in the course of time, be thoroughly carried out; nor does it afford us protection from damage to and by inflammable materials already exposed to risk. For the extinguishment of fires, and especially of large conflagrations, the most generally used and most effective appliances are Steam Fire Engines, of various types. These we purpose briefly mentioning, selecting the most prominent makes of each type, and pointing out some defects in construction possessed wholly or in part by all of American build—although these have, in many points, surpassed those of any other country.

The essential parts of a Steam Fire Engine may be classed as the Boiler, Working Gear and Running Gear; their importance being rated in the order named. In the construction of the first two elements, there is and has been fierce competition.

We shall first consider, as thoroughly as possible, the Boilers of Steam Fire Engines; and in this consideration shall state what the theoretically perfect boiler should be, and then classify those now most generally made, giving in detail, for comparison, the elements and dimensions of individual styles.

The Boiler of a Steam Fire Engine should be light, strong, compact; a rapid generator of dry steam; with comparatively large grate and heating surfaces; capable of being "forced," on occasion, to extra duty; should steam well on inclined ground, and foam as little as possible when supplied with muddy or brackish water; should be hung low, and be readily accessible for repairs; the draft should be swift and sure, unaided by the exhaust, or other means of forcing. Where extreme compactness and portability are such positive requirements, to avoid the bulk and weight of a large body of water, and the delay of bringing such a large mass to the boiling point, the object should be to feed and generate rapidly; hence the feed should be adjustable with great delicacy, and the feed-water supplied as hot as possible. To inject cold (and in some cases *ice*-cold) water into a boiler has a similar effect to that produced by feeding an occasional lump of ice into the fire-box, or allowing the fire-door to stand open continually. It is very bad economy and still worse policy. A saving of twenty-five per cent. of the fuel may be effected by hot feed; while the danger from contraction, where cold water comes into contact with highly heated plates, is not to be overlooked. It may be of advantage to have a dump-grate or other means of drawing the fire instantly in case of danger to the boiler from low water or other causes; but a bad dump-grate (and most of them *are* bad) is worse than none at all. Economy in consumption of fuel is difficult of attainment in a Steam Fire Engine; still, it is desirable that the fuel should not be carried out of the stack bodily and unconsumed, as is often the case. Further on we shall allude to the cause of this latter fault, and suggest the proper remedy.

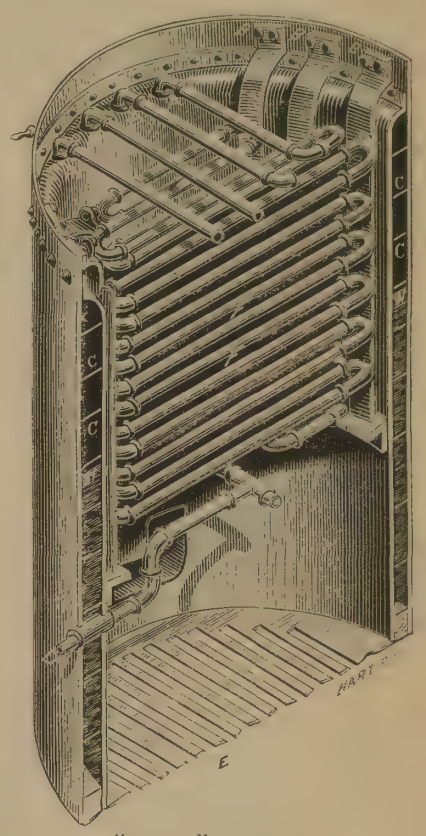
The vertical style of boiler is now adopted, without exception, for American engines. These may be divided into those having (1) water-tubes, (2) smoke-flues, and (3) both tubes and flues. Those with water-tubes give, generally, the best results; according in this with experience in marine and stationary boilers. A subdivision of the tube-boilers might be made into those with circulation (1) natural or unaided, (2) aided, and (3) forced. The tube-and-flue boilers have aided circulation; while the construction of the flue-boilers permits of natural circulation only. The most marked style of water-tube boiler is that of the "Latta" engine, built by C. Ahrens & Co., of Cincinnati. This has "forced circulation," and is unlike any other used for the purpose. It is here shown in vertical and horizontal sections, and consists of a double or annular shell (or jacket) forming steam and water space, and which forms the fire box; within this is securely fastened a long coil, through which the feed-water is *forced*, thus giving abundance of heating surface, and preventing the burning of the parts exposed to the fire. It makes steam very rapidly, and retains the desired pressure. The coil has sufficient room in which to expand and contract, and thus there is no strain to loosen steam joints. The water is supplied to the coil by a circulating pump, making a forced circulation, and preventing sediment or scale from collecting in the tubes. The cuts give a very clear idea of the construction of the boiler.

Water is drawn from the jacket by a circulating pump, and forced into the coil D, generating steam while passing through FF, the remaining water with the steam returning into the boiler at AAAA; there being no heat wasted by putting too much water in the coil. BB are upright slats supporting coil. By removing bolts out of slats BB, breaking joints top and bottom, any section or all sections of coil can be removed, should any repairs be necessary, and any or all may be replaced in a few hours.

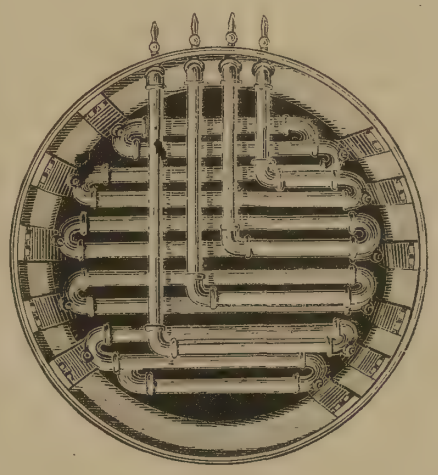
The water, in entering at D, is separated into two parts, and then into four, by a device inserted in the dividers at the bottom, so that each section receives an equal amount of water. E represents the grate-bars; W, the water-line. From thirty-two to forty gallons of water can be carried without interfering with the generation of steam. Steam can be generated as readily with thirty-eight gallons of water as with thirty. C indicates steam-room.

The makers say:—"We guarantee this boiler to make sufficient steam for our engine to throw water from a nozzle inside of *four* (4) minutes from the time of lighting the fire.

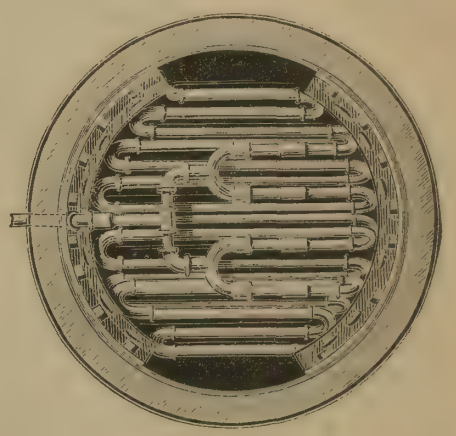
"The oldest engine in use in the department here (Cincinnati), was built in 1858, and, up to date, her boiler has not cost one cent for repairs; and now generates steam and throws water inside of five minutes from the time of lighting the fire."



"LATTA" BOILER.
[Longitudinal Sectional View.]



TOP VIEW.



BOTTOM VIEW.

The "Latta" engine is the only one known to us employing the principle of "forced circulation."

In our next issue we shall describe and illustrate, in detail, those boilers which have both tubes and flues, and employ aided circulation. †

[*To be Continued.*]

LIGHTNING STROKE.

The Committee of Science and the Arts, of the Franklin Institute, has appointed a sub-committee to report upon "the visible effects of lightning, and the best means of protecting property and life." This sub-committee is now engaged in collecting and collating material upon this subject, and all persons having accurate and reliable detailed information concerning cases of lightning stroke, are requested to forward it to the editors of this journal, for the use of the sub-committee. Due acknowledgment will be made of all such favors.

GAS AND OIL ENGINES.

The history of civilization is the record of man's efforts to make the forces of nature his servants. The wind and the water were early impressed into his service to bear him from place to place, and later, to drive his crude machinery with uncertain and varying power. Fire served, at times, as his slave in preparing his food, hollowing his rude canoes, and enhancing his comfort; while again the quondam willing servant rose in might and played the part of a cruel master, a devastating tyrant. We find, then, that air and water, as the zephyr and the streamlet, were more relied upon for constancy and docility in service than the flame. It is not yet two centuries since the ambitious and domineering spirit of man placed him firmly in the position of conqueror over the genius of fire, which position, constantly strengthened, he has rarely allowed himself, even for a time, to lose. There are, even now, times when man's carelessness has allowed the fire-fiend to sweep a city from existence; but for all that, year in and year out, from Savery's time until the present day, fire has been compelled to act the part of burthen-bearer; to serve as a "hewer of wood and drawer of water." But from its fierce and impetuous nature, fire cannot often be trusted alone to perform any of man's labors, but has required a co-laborer, a yoke-fellow to steady, control and equalize its fitful and impulsive force. Savery, in 1698, invoked the aid of water to avail himself of the energy of fire in saving and furthering man's labor; and the steam-engines which have succeeded the crude but progressive efforts of Savery, Newcomen, and Watt, have all, down to these days of Corliss, been designed in recognition of the idea that fire must be harnessed with a slower, steadier mate, and water has been chosen as that mate. But the phlegmatic disposition of the water-slave, the weight and strength of the harness necessary to utilize its immense power, and the length of time required to awaken its dormant energies, have ever been hindrances to the impatient progress of the period. The age of steam is giving way to the age of lightning, and bold attempts have been made to apply the flame unhampered with a yoke-mate, and even to conquer and train Olympian flashes to do the work of errand-boy and seamstress. The greater rapidity with which flame-engines and electric motors may be brought to maximum action from a state of rest, and the immunity from the sickening horrors of boiler-explosions, have, together with the gradual cessation of improvement in the steam engine, led inventors to driving light machinery by flame and electricity. The great expense of the galvanic battery, as a source of power, has, however, of necessity confined its application to those household purposes where economy may be sacrificed to convenience. The application of flame in the hot-air engine, was, as regards convenience, safety and rapid attainment of maximum and continuing power, a great step forward; but the exigencies of economy have debarred this motor, using fire and air, from competing with the steam engine, using fire and water.

Attempts have been made to combine the three agencies, in the "aëro steam engine," but as yet its use is so limited as to preclude any extended comparisons.

The close of the last century witnessed the application of coal-gas (which had been known experimentally since 1739) to illuminating purposes. As its use became more extended, its properties more familiar, the cost of production constantly lessened, and its sources multiplied, a new field was opened to investigators and inventors. Its explosive nature, when in combination with air, so strongly contrasted with the mildness and steadiness of its flame, unmingled, as to suggest at once the practicability of employing this explosive force as a motive power.

The methods first adopted for utilizing the explosive force of coal-gas and air, required repeated ignition of separate charges, while under confinement in a cylinder, by introducing an electric spark. To this system there are two objections: (1) the uncertainty of igniting the charges, and (2) the difficulty of supplying exactly the quantity of air to meet the variations in the chemical constituents of the gas, and at all times produce the same explosive action, in harmony with the piston movement. The Lenoir, the Otto & Langen, and the Hugon engines failed from these reasons, although the latter received the silver prize medal at the Paris Exposition of 1867.

In 1872, Mr. George B. Brayton largely obviated these difficulties by *avoiding* the use of *explosive* action. In his gas engine Mr. Brayton introduced with success the following principles: (1) maintaining a limited quantity of gaseous mixture, under considerable but uniform pressure, in a reservoir; (2) introducing a jet of the mixture, while in the act of changing its volume from ignition, into a cylinder in which its expansive force (supported by the reservoir pressure) acts upon a movable piston. To carry out these principles there were necessary (1) a pumping engine for condensing air and gas, (2) a reservoir for containing these agents of force, (3) a cylinder and working piston, (4) suitable automatic valve-gear, (5) a flame-intercepter, whose office it was to maintain a living torch within the cylinder, and prevent firing the gaseous mixture in the reservoir.

Careful tests of such an engine were made by Professor R. H. Thurston and Mr. R. H. Buel, and show that with this system combustion is not explosive, indicator-diagrams showing the pressure to be exerted and maintained precisely as in a steam engine. While the tests by Professor Jenny, of Vienna, showed the Otto & Langen engine to consume 38.10 cubic feet of gas per horsepower per hour, and the Lenoir and the Hugon have been rated at from 70 to 95 cubic feet, the Brayton gas engine used but 32.06 cubic feet. This increased economy could not result solely from improved workmanship, but is evidently the result of the application of the principle of maintaining and using a steady pressure in a reservoir corresponding in action to the boiler of a steam engine.

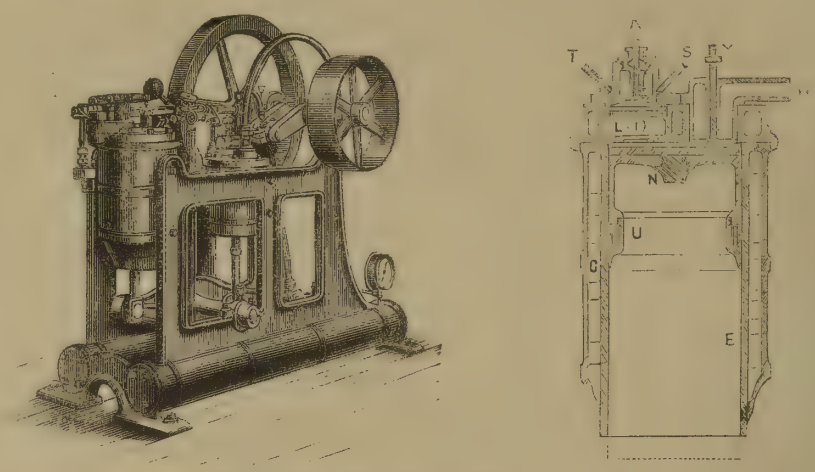
All these gas-engines had this bar to their application in the very places where their value would be most appreciated:—their use was dependent upon the pre-existence of gas-works, or of a natural flow of gas such as that so long employed in Fredonia, N. Y., and latterly introduced in Butler county, Pa., for heating, illuminating and manufacturing purposes.

But meanwhile the opening of the treasures of the Pennsylvania oil regions, and of minor sources of natural hydro-carbon oils, flooded the country with both useful and waste products, and developed new and valuable industries. It was discovered that the vapor of the lighter distillates mingled with air at normal temperature and pressure, forming mixtures which were illuminating or explosive according as the proportion of air was less or greater; and that the heavier distillates would at high temperatures be broken up into hyro-carbon vapors, which, suitably admixed with "water-gas," at still higher temperatures, would be fixed as illuminating gas of greater cheapness and purity than that produced from the destructive distillation of coal, rosin or other solids previously used.

It had not been practical to use, as illuminating or heating agents, the vaporous mixture, or mingled spray and air, made from the heavy hydro-carbons and highly compressed air; and the vapor-flame produced from light hydro-carbons, although of dangerously wide and extending use as an illuminant and source of heat, had not been thought of or applied as a motive power.

The application of cold-vapor as a source of power, in a machine somewhat similar to his already successful gas-engine, enabled Brayton to extend the use of his flame-engine (as modified to suit the newly-chosen flame-producer) to those localities which had, from lack of gas-works, previously been debarred from the use of any gas-engine, while at the same time the use of vapor instead of gas solved most effectually and satisfactorily the question of cost.

The Brayton "hydro-carbon" engine is here shown in perspective, and the working cylinder in section:



BRAYTON'S HYDRO-CARBON ENGINE.

At the left-centre of the engraving (and again in enlarged section) is seen a water-jacketed working-cylinder or combustion chamber. At the centre of the machine is seen an air-compressing pump, actuated from the working-cylinder, and communicating, by a curved pipe, with two cylindrical air-reservoirs constituting the base of the frame. A tiny oil-pump in the left background supplies the fuel as needed for combustion. The action of the engine may be thus briefly stated: The oil-pump feeds a few drops of liquid fuel through a small tube (S) into an annular chamber containing felt; here the hydro-carbon encounters a blast of compressed air, which enters through the tube (T), and by which it is vaporized; the mingled air and vapor are forced in proper proportion through the felt, and when lighted at I, and this is closed, burn expansively, driving the metal piston (U), downwards and forwards; at the end of the stroke the compressed-air inlet (T) is closed, and the exhaust valve (Y) opened; the momentum of the fly-wheel carries the piston backwards and upwards, forcing the products of combustion out through the exhaust pipe (H); this stroke of the piston compresses sufficient air, by means of the pump, to atomize or vaporize the next charge of oil; the cutting off of the air supply at the end of the down stroke extinguishes the main flame, but a tiny, independent gas-jet, burning continuously in the chamber L, under pressure from behind, lights each supply or charge from the main jet, thus effecting the successive down strokes of the piston. At A is an adjustable spring safety-valve. The supplies of oil and air are adjustable. A gauge attached to the reservoirs shows the pressure of the compressed air. Ordinarily, but one of the reservoirs is used, the other being kept charged in order to effect the instant starting of the engine. This is so rapidly accomplished, that we have seen the full working pressure and power reached in sixty seconds from the time of applying the match and closing the orifice I. It is claimed that one gallon of crude petroleum, produces one horsepower for ten hours, at a cost, in Philadelphia, of ten cents.

This "Ready Motor" is the invention of Mr. George B. Brayton (also the inventor of the Exeter Sectional Safety Boiler), and is manufactured by the Pennsylvania Ready Motor Company, 132 NorthThird Street, Philadelphia. Sizes of one, three and five horse-power are now built, while engines of ten horsepower are in course of construction. †

'A JUSTIFYING TYPE-SETTING MACHINE.

Many fortunes and many years of valuable time have been devoted to producing a Type-Setting Machine, which would do cheaply and effectually, but more rapidly and with unskilled labor, that work which is now performed by skilled hands only, at a comparatively high cost and slow rate of speed. It were needless to enumerate, particularly, the inventions and attempts designed to accomplish type-setting and distribution, most of those in the field evidently aiming at composition merely as an adjunct to distribution, which last is of a more strictly mechanical nature. Suffice it to say that the inspection of the machines and perusal of the patent records reveal an astounding array of levers and wheels, pulleys and belts, nicks and hooks, tapes and turn-tables; their construction requiring the nicety of a chronometer, with the complexity of a calculating machine. Heretofore none of these machines have succeeded, for the reason that they were complicated in construction, costly of manufacture, extremely liable to get out of order, and in many cases required special type prepared for them; moreover, none of these machines accomplished more than to set up a line of type, which required to be "justified" by hand. The problem seems one of astonishingly tedious and difficult solution. The prerequisites of success are many and imperative. Were all our ordinary characters or types of equal width; were it unnecessary to punctuate or to "paragraph;" did our words, or even our syllables, average actually or nearly the same length, the solution might be one of greater ease. But such is not the case. We have letters or types in each "font" varying in width from that of i to that of m,—a graded series of lower-case letters being shown in the word m i e n s, and their widths more strongly contrasted in the built-up rows, each of thirty letters, as—

iiiiiiiiiiiiiiiiiiiiiiiiiiiiii
ssssssssssssssssssssssssssss
eeeeeeeeeeeeeeeeeeeeeeeeeee
nnnnnnnnnnnnnnnnnnnnnnnnnn
mmmmmmmmmmmmmmmmmmmmmmmmmm

The shortest word we have is "a;" one of the longest monosyllables is "thoughts." As it is, then, there must be accomplished (and that, too, with extreme rapidity, certainty and care) the building-up of a series of lines of minute, metallic prisms, of different heights and widths, and which must, of necessity, be arranged with a certain end up and a given edge to the front; moreover, this line must be of a definite length, and within this limit there must be, if possible, no fractions of words; certainly, no fractions of syllables. It is evident that either the syllables or the spaces in these lines must be varied in length to accommodate the exigency of making complete lines contain integral words or syllables. The spaces must be the variable element. But, again, to meet the requirements of good taste and of beauty, all the spaces in any given line should be of equal width. Herewith we show a line equally and the same unevenly spaced:

"Worth makes the man; the want of it, the fellow."

"Worth makes the man; the want of it, the fellow."

Spacing is not perfect unless regular. Still, there are cases where theoretical perfection may not be attained with the means at hand. The spaces furnished with our ordinary fonts of type are only aliquot parts (halves, quarters, thirds, fifths and sixths) of the standard "em." It would then be impossible to space or "justify," with theoretical accuracy or correctness, where the number of words among which a deficiency must be divided will not admit of each space being an aliquot part, or a very simple fraction of an "em." Where this cannot be effected, that division must be effected which will give a regularity of spacing, approximately exact and sightly. This mode is adopted by all compositors, and we cannot attain any better results by machinery. We will then denominate this "exact" spacing, or justifying.

The most ingenious mechanics have bravely battled to conquer even the first difficulties—those of effecting the mere linear composition without justification. Among these, the name of the late Timothy Alden is conspicuous; and he deserves especial commendation for his persistence, and for the ingenious combinations of complicated mechanical movements which he employed to effect the desired end; and the use of which was necessitated by the roundabout way which he adopted to secure his primary results. The Rittenhouse clock, the automata of Vancanson, even the calculating machine of Babbage, were more simple than the Alden machine. The legacy of promise was bequeathed to the second Alden, who, by the aid of a powerful and influential company, succeeded, as others had done, in setting up a long line of type, which had been hooked by barbed needles, gripped by timely pincers, dandled along friendly tapes, and whirled round by relentless cylinders, to its place in line, where, the powers of the machine having been exhausted, the intelligent compositor, or justifier, gave the character a local habitation as well as a name. It was a wonder, a marvel; but not a triumph, a success. The want was yet unsupplied. Inventors thirsting for fame, and yearning for its frequent concomitants—ease and wealth—still racked their brains and burned the midnight oil to produce the desired result; but success for them was not. It is only recently that the problem has received that reasonable and perfect solution which calls from us these lines. The following article, copied in the *Scientific American*, of May 29th, 1869, from the *New York World*, of recently previous date, was set up and justified by the Corey and Harper Justifying Type-Setting Machine, of this city:

"It is discreditable to the inventive genius of this country, that the one great mechanical want of the time is unsupplied. Each of the leading newspaper publishers of this city, apart from expenses for white paper, presswork, ink, editorial, reportorial and correspondents' salaries, and the thousand incidental demands for a great daily, pays from $100,000 to $200,000 a year, for composition alone. Publishers, throughout the country, of newspapers, magazines and books, pay proportionately for this single item of type-setting. This enormous cost prevents the publishers of papers from giving their readers the literal volumes of matter they would gladly do from day to day were they not hampered by the delays and the costs of composition. What we want—what every large publisher in the country wants—is a type-setting machine which will both expedite and cheapen the cost of composition at least 25 per cent., and perhaps 50 per cent. Type-setting should be so cheap that publishers can print books and papers in this country and sell them at the low prices which obtain in England. A London house has printed the "Pilgrim's Progress," in clear type, on good paper, so that the book can be retailed for a penny. News and illustrated papers are sold in England, at nearly proportionately low rates; we have not, as yet, reached this point of progress in this country, although, in proportion to our population, there are more readers here than in any other nation on the globe. We want the means of supplying the demand for reading matter. The inventive genius of this country produced the steamboat and electric telegraph. It is fully equal to the perfect type-setting machine which shall rapidly and cheaply do the entire composition of publishers of the country. Nothing else so profitably suggests itself now to American inventors. We invite the press of the country to join in subscribing for a prize that shall be worthy of the attention and competition of every skilled inventor in the country. This prize should not be less than half a million dollars; and if the leading publishers in the country can be induced to combine in such an offer, the WORLD will gladly head the list with twenty-five thousand dollars as its own subscription. To the successful man who produces the called-for instrument, a quarter million dollars would be gladly given by the publishers of the country. The prize will, undoubtedly be offered. The demand for the type-setter is imperative!"—NEW YORK WORLD.

"The want expressed by our cotemporary, is, no doubt, a serious one."—SCIENTIFIC AMERICAN.

This machine has practically accomplished, not only the mere rapid setting of type by simple, compact and inexpensive mechanism, but at the same time performs automatically, with great precision, and without the possibility of error, the operation of justifying, heretofore pronounced impossible by most former inventors and authorities who have given any attention to the subject. The actual accomplishment of this fact, after so many signal failures, and by such simple means, is worthy of special remark.

In one modification of the Corey and Harper machine, the types are arranged in rows, upon their sides, upon a horizontal table, and in transverse parallel grooves, which run at right angles to and open into a longitudinal groove of sufficient width to admit of but one type at a time, from any groove, entering or sliding longitudinally therein. In this groove a reciprocating "pusher" travels, discharging the type into what corresponds to the "stick" or galley, at the left end of the table. A rapid motion of the finger draws a type from its transverse groove into the longitudinal groove, and the pusher, which passes over the type, on the up-stroke, from left to right, pushes it on the down-stroke into the galley, depositing it over those types previously set, and thus building up a vertical line of types. (A longitudinal "stop" is at each stroke brought up against the outlet of the transverse type-channels or grooves, to prevent types slipping into the longitudinal channel except when placed there by the finger or by suitable mechanism.) By an arrangement of the grooves, the letters of the more frequently recurring short words may, by the fingers of one or both hands, be brought at once into the longitudinal groove. At the end of each word, one of a chain of brass "spaces" or "quads" is brought into the vertical line, from the back or left side of this line. As each type or brass space is placed in line, an indicator shows the number of "ems" already set. When the proper number of words has been placed in line, the index shows this number of words, and number of "ems" required to complete or space out the line. At this point, the justifying feature of the machine comes into play.

If there are five words in the line, with a deficiency of two ems, it is readily seen that one "en" space must be introduced between each two words to make the line full or complete. Pressing a foot-lever the words in the vertical type-line are brought up in order, and between each two words an "en" space or quad is introduced from the right, in the same manner as the type, and the brass space is withdrawn to the left. The line then being complete, as shown by the indicator, it may be pressed back into the stick or galley, and another line may be rapidly set in the same manner as the first.

The dial of the indicator is divided into magnified parts of what printers term "ems"; these parts being subdivided into fourths and fifths and into "hair" spaces, or sixths of an "em."

It may readily be seen, if we take for example a line of type which printers term "hair-spaced," containing seven words, allowing six spaces to be placed in the line, one between each two words, that if the dial show a deficiency of one "em" at the end of the line, six $\frac{1}{6}$ "em" or "hair" spaces will make up that deficiency. The following table will show how the indicator would stand for seven words, (the first four positions of the dial seldom if ever occurring).

DEFICIENCY.	EQUIVALENT.
1 em	$6\frac{1}{6}$ em spaces.
$1\frac{1}{6}$ ems	$5\frac{1}{5}$ ems, $1\frac{1}{6}$ em.
$1\frac{1}{4}$ ems	$5\frac{1}{5}$ ems, $1\frac{1}{4}$ em.
$1\frac{1}{3}$ ems	$4\frac{1}{4}$ ems, $2\frac{1}{6}$ ems.
$1\frac{1}{2}$ ems	$6\frac{1}{4}$ ems.
$1\frac{2}{3}$ ems	$2\frac{1}{3}$ ems, $4\frac{1}{4}$ ems.
$1\frac{3}{4}$ ems	$3\frac{1}{3}$ ems, $3\frac{1}{4}$ ems.
$1\frac{5}{6}$ ems	$4\frac{1}{3}$ ems, $2\frac{1}{4}$ ems.
2 ems	$6\frac{1}{3}$ ems.

And so on indefinitely; using the ordinary printers' spaces as now made. The same principle will apply to any number of words in a line. Most lines will admit of six spaces between the words, therefore extraordinarily good spacing can be made. Take, for example, one of the longest monosyllables in English—"thought." Say the word comes at the end of the line. The index would show three "ems" deficiency. Six en quads, one between each two words, would make up that deficiency, which is excellent spacing in an extreme case. It is obvious, therefore, that there is no possible requirement of justification that the machine will not meet, and the justification is mathematically exact. The mechanism is simple, and all the movements positive. There are no tapes to stretch or break, as the machine is wholly of wood and metal; no hookings or grippings; the type lie in the easiest position, and in the most simple arrangement.

The speed is many times faster than any attainable by hand composition. Allowing a rate of only two types per second, inclusive of justification, the capabilities of the machine are 120 type or 50 ems per minute, or 30,000 ems per working day of ten hours. The maximum average rate of hand composition is only 6,000 ems per day of ten hours.

The work of distribution upon the horizontal table is very simply performed by means of a cylinder placed at the back of the table, at right angles to the transverse type grooves; and may be accurately performed by another operator at the back of the table, at the rate of 5,000 ems per hour, at a cost of two cents per thousand; or, if necessary, by nicking the type, this operator may be dispensed with. †

HALL'S SUDDEN-GRIP VISE.

We present herewith illustrations and description of an invention of Mr. Thomas Hall, of Brooklyn, which has attracted considerable attention:—

The vise is held in its place on the table by an automatic swivel, on which it is free to move. Attached to the movable jaw is a handle, by which it can be moved to and from the fixed jaw between the extreme limits of its traverse, while the faces of the jaws remain perfectly parallel under all circumstances. When any article is to be held in the vise, the moving of the handle instantly adjusts the jaws to hold it, whatever its size, and the grip of the jaws is as easily and quickly loosened by moving the handle in the reverse direction. It is only necessary to push the movable jaw against the article to be held, and then depress the handle, as in Fig. 2, when its weight produces a powerful grip and locks the vise tightly, besides locking the swivel at the angle at which the article is gripped. The arrangement by which this automatic locking of jaws and swivel is produced is very

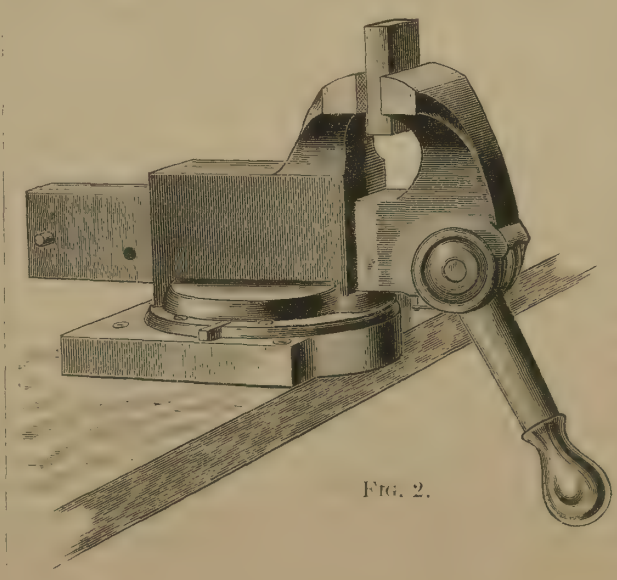


FIG. 2.

ingenious, and, so far as we know, quite original. When there is nothing between the jaws, or so long as the handle is held up, the vise can be turned on its swivel at the will of the operator, as shown in Fig. 1; but the moment the grip is set, the vise becomes immovable upon the table. By raising the handle again, both jaws and swivel are set free simultaneously. In the sectional cut, marked Fig. 3, the mechanism by which this is

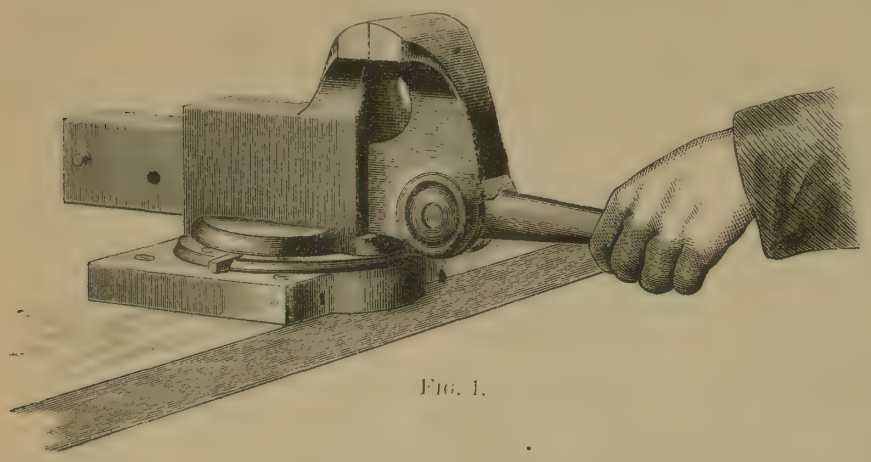


FIG. 1.

accomplished is shown very clearly. B is the stationary jaw through which the movable jaw A, the straight part of which is cored out, passes. P is the bed-plate, made in two pieces so as to be adjusted into the dovetail formed by the lower portion of the jaw P.

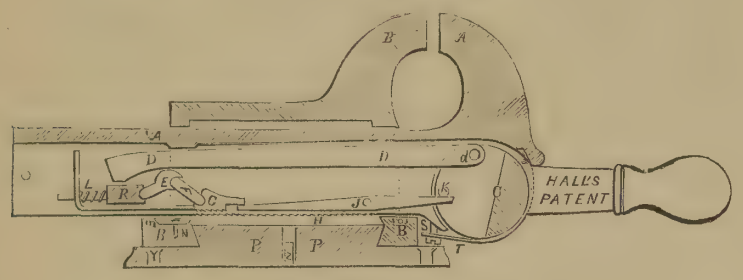


FIG. 3.

To retain this plate in place, a wedge W is driven in between the sections, spreading the same just sufficiently to make a neat fit with the jaw base. Above the plate P, and held in front and rear by the lower portions of B, is a steel rack-plate H. The rear end of this is secured, and the entire plate prevented from rising by the screw N. The lever handle has cast, on each of the sides of its inner end, a disk. These disks are inserted in a socket in the outer extremity of jaw A, and held in place by friction straps T, which are adjusted to hold said disks loosely or tightly by means of the set-screws S. On the inner portion of the disks is a pin K, which, when the lever is raised, as shown, presses down the end of a pivoted bar J, located inside the hollow jaw. This bar raises the toothed clutch G, and disengages the teeth of the same from the rack H. Under these conditions it will be seen that, by pulling or pushing on the handle, the jaw A may be drawn out or shoved in very easily, and so adjusted in contact with the work. As soon as this is done the lever-handle is pushed down. The effect is to release the lever J, and so as to allow clutch G to drop, and also to draw a bar D, which is pivoted to the handle disks, outward; and thus the end of the bar acts as a wedge to push down the joint E E, and so to force the clutch G forward, to act against the rack-teeth. As the part E of the clutch bears against the bar R, which is cast with the jaw A, it is evident that, acting on the bar R as an abutment, the extension of the toggle-joint tends to carry jaw A inward with great force, and so to grasp the object inserted between the jaws, very tightly. As soon as the lever is raised to loosen the work, the coiled spring L, acting on the upward turned end of the clutch G, carries the latter to the rear, and so removes it from the rack-teeth, and at the same time returns the toggle-joint to its normal position. It will be seen from this that the tendency of the downward, as well as backward, thrust of the toggle-joint is to raise the jaws. This action is also utilized to prevent the turning of the vise on its swivel after the grip is on.

The chief point of merit in this vise is the ease and rapidity of its operation and the steadfastness of its grip. It is also very strong. When the handle is depressed it is entirely out of the way of the workmen. This vise received the Medal of Progress and a diploma of honor at the Vienna Exposition, and the first premium at the fair of the Franklin Institute, Philadelphia, in 1874—the only times it has been exhibited. These vises are claimed to be adapted equally to heavy and light work.

For the text of the foregoing description, we are indebted to our contemporary, *The Iron Age*.

PRODUCTION OF THE PENNSYLVANIA OIL WELLS.

BY HENRY E. WRIGLEY.

[*From the Second Geological Survey of Pennsylvania. J.*]

During the fifteen years which have passed since the striking of the Drake well, the Pennsylvania Oil Region has produced up to January 1st, 1875, sixty-seven millions seven hundred thousand barrels of oil, which brought at the wells the sum of two hundred and thirty-five millions five hundred thousand dollars. Of this amount, 3,200,000 barrels are stored to-day in the tanks of the Oil Region.

The following table of production, price and export, will show more fully the progress of the business from year to year:

YEAR.	Production in barrels.	Average price for the year.	Amount.	Barrels exported crude, equivalent.	Crude, value of export at the wells.
1859	3,200	31 cts. gallon.	$41,664 00	.....	.....
1860	650,000	16 " "	4,368,000 00	.....	.....
1861	2,113,600	$2 73 barrel.	5,770,128 00	27,812	$75,926 76
1862	3,056,606	1 68 "	5,135,098 08	272,192	457,282 56
1863	2,611,359	3 99 "	10,419,322 41	706,268	2,818,009 32
1864	2,116,182	9 66 "	20,442,318 12	796,824	7,697,319 84
1865	3,497,712	6 57 "	22,979,967 84	745,138	4,895,556 66
1866	3,597,527	3 73 "	13,418,775 71	1,685,761	6,287,888 53
1867	3,347,306	3 18 "	10,644,433 08	1,676,300	5,330,634 00
1868	3,715,741	4 15 "	15,420,325 15	2,429,498	10,082,416 70
1869	4,215,000	5 85 "	24,657,750 00	2,568,713	15,026,971 05
1870	5,659,000	3 80 "	21,504,200 00	3,530,068	13,414,258 70
1871	5,795,000	4 35 "	25,208,250 00	3,890,326	16,922,918 10
1872	6,539,103	3 75 "	24,521,636 25	4,276,660	16,037,475 00
1873	9,879,455	1 84 "	18,178,197 20	4,981,441	9,165,851 44
1874	10,910,303	1 17 "	12,765,054 51	4,903,970	5,737,644 98
	67,707,094	$3 48 barrel.	$235,475,120 35	32,490,971	$113,950,153 26

Total production, 67,707,094 barrels; average price, $3.48; total value of yield at wells, $235,475,120.35; total amount exported, 32,490,971 barrels; total value at wells of crude oil exported, $113,950,153.26.

The refining of this oil at a cost of two dollars per barrel, on seventy-five per cent. of the total amount, makes an additional value of over one hundred millions.

There has been exported a crude equivalent of thirty-two and a-half millions of barrels, the value of which, at the wells, without refining, freight or handling, was one hundred and fourteen millions of dollars.

The freight on forty millions of barrels to the seaboard, at an average of $2 50 per barrel, would amount to one hundred millions. So that the value received from abroad for the export would exceed, at a minimum estimate, the sum of two hundred and sixty millions of dollars.

The total number of wells drilled in the region from the start to January 1, 1869, on or near actual producing territory, was 5,560; the amount of oil produced up to January 1, 1869, was something less than 25,700,000 barrels, giving the entire average production of each well at nearly 4,600 barrels. The amount realized for oil up to January 1, 1869, gave an average of $4.06 per barrel, or $18,700 for each well.

From that time forward until the present, the outline of the underlying strata being better understood and defined, and the failures proportionately less, the figures are as follows:

In 1869, there were drilled	991 wells.
In 1870, " "	1,007 "
In 1871, " "	946 "
In 1872, " "	1,032 "
In 1873, " "	530 "
In 1874, " "	433 "
*Total from 1869 to 1874, inclusive,	4,939 "

At round numbers, five thousand wells have been drilled since January 1, 1869, producing forty-two millions of barrels, at an average price of $2.91, giving a production to each well of 8,400 barrels, and a gross earning of $24,500. Of the 10,500 wells that have been drilled on or near actual producing territory, 3,250 are pumping to day, with an average production of less than ten barrels each.

It will be seen that during the last six years, we have nearly doubled the average entire production of a well, with but a slight increase in gross revenue. It will also be observed that three hundred wells drilled before January 1, 1871, are pumping to-day.

Making a fair allowance for wells recently started, we shall have the average life of a well at a little over two and one-half years. The annexed table and diagram are given to illustrate this point.

If the cost of drilling the 5,560 wells up to January 1, 1869, was $4,000 each, the cost of drilling was $22,240,000. If the cost of drilling the 5,000 wells since January 1, 1869, was $6,000 each, the cost of drilling was $30,000,000. Assuming 8,000 wells to have been a success, and to have averaged a life of two years each, at a cost of $10 per day for all expenses and shut-downs, the cost of pumping would be $58,400,000.

The cost of 39½ square miles of actual producing territory, 25,280 acres, at $500 per acre, $12,640,000. The petroleum account, therefore, of the actual producing territory only, taking no account of failures or outside operations, is as follows:

Total amount received at wells, to January 1, 1875,		$235,475,120
Cost of drilling,	$52,240,000	
Cost of pumping,	58,400,000	
Cost of territory,	12,640,000	
	$123,280,000	
Profit,	112,195,120	
	$235,475,120	$235,475,120

The net profit, therefore, of producing 67,700,000 barrels of oil, was $112,200,000, or $1.67 per barrel. If it were possible to include in any statement of this kind the amount expended in "wild-catting" and speculation, it is doubtful if the net profit would amount to $1 per barrel.

Much more information of interest can be deduced from the tables given, but it is better that the estimates should be made by the parties who seek it. One further instance only will be given:

We received in 1874 for our oil at the wells,	$12,765,000	
We paid for drilling 433 wells, @ $5,000,		$2,160,000
We paid for pumping 3,300 wells, $5 ℔ day,		5,940,000
We have increased our stock of crude on hand, 1,400,000 barrels, @ $1.17,		2,380,000
Balance,		2,285,000
	$12,765,000	$12,765,000

* This estimate of wells drilled, is exclusive entirely of those bored on outside non-producing territory.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

A New Croton Aqueduct.—Commissioner Fitz John Porter lately submitted to the Mayor of New York city a report on the surveys, plans, and estimates for a new aqueduct. As one of the reasons for the erection of a new means of water supply for the city, the Commissioner says that the reservoirs contain sufficient for ten days only, and that in case of accident to the existing aqueduct that would require more than ten days to repair, the water supply would cease. As to the capacity of the Croton basin to furnish the water that the new aqueduct would require, he says that 300,000,000 gallons flow over the Croton dam daily, most of which might be brought to this city. His plan contemplates the building of a dam on the Croton river, thirty feet above the top of the existing dam, forming a settling basin of 800 acres, and a capacity of 1,180,000,000 gallons. From thence a tunnel would be cut through the hills south of the Croton river, through which the water would be conveyed to the head of the aqueduct, which would extend to High Bridge, and be built either on the Bronx river route, which is about thirty-six miles long, or on the Saw Mill river route, which is about the same length. The masonry aqueduct would stop near Jerome Park, where it is proposed to build a receiving reservoir to hold 600,000,000 gallons. Iron pipes would run thence to the Central Park reservoirs, crossing the Harlem river either on High Bridge, or under the sidewalks of the tunnel that the Park Department intends to build under that stream. The new aqueduct would deliver 150,000,000 gallons of water daily. The Commissioner estimates the cost at $10,000,000.

Delaware River and Harbor Improvements.—Lieutenant Colonel Kurtz, the United States Engineer in charge of the river and harbor works of the Delaware river and its tributaries and Delaware bay, reports that it is intended this year to increase the length of the Lewes pierhead 21 feet, to complete the new ice-pier at New Castle, and remove the old coal wharf, to remove 23,000 cubic yards of mud and gravel and 75 of rock from the channel at Wilmington, to finish the work at Marcus Hook, to repair the ice-piers at Chester, to deepen the channel of the Schuylkill at its mouth, to widen the channel at Fort Mifflin bar to 1,500 feet, to lower the Bulkhead shoals to 21 feet, and the channel of Cohansey creek widened and deepened. The improvements thus far made in the navigation have handsomely increased the commerce of the Delaware, attracted larger vessels, and established an enhanced trade with foreign ports in the export of domestic products.

Reclamation of the Zuyder-Zee.—The reclamation of the Zuyder-Zee has long been contemplated by the Dutch people and Government, in whom the hereditary instinct of conquest from the sea still survives. At the late session of the legislative body an appropriation was made for soundage and survey. It is now proposed to reclaim about half the surface of the inlet designated as the Zuyder Zee by some geographers, or the whole of it according to others. An enormous dike, 40 kilometers, or 24.85 miles long, is to be constructed from Kampen, near the mouth of the Yssel river, on the eastern shore, to Enkhuizel, on the western shore. The dike is to be 23 feet above the water surface, with an upper parapet 16½ feet high and 10 feet wide on the top, sloping down to an exterior berme or bench, 16 feet wide and 6½ feet above the water. An interior berme will serve first as a tow-path to a canal, and afterwards as a track for a railway after the reclamation shall have been finished. The dike will cost 53,000,000 francs, or over $10,500,000, and the entire expense of the whole work is estimated at 180,000,000 florins, or $87,120,000, allowing a value of one-tenth of a British pound sterling for each florin. The area embraced in the project is about 481,864 acres, of which 46,950 acres will be needed for highways, canals, basins, etc. The remainder, 434,914 acres, will represent the amount of land disposable at a cost of about $200 per acre. Last December the Government sold 875 acres of land reclaimed from Wykermeer, at an average of $1,051 per acre. At this rate per acre, the National Treasury would receive a prompt reimbursement of the expense with a surplus of 100 per cent., or a clear profit of $370,000,000. This, however, is somewhat excessive, but the surplus could scarcely be less than $200,000,000. There is a difference of opinion as to the time necessary to complete the work, the estimates varying from twelve to sixteen years. The average depth of the Zuyder-Zee is stated at 4½ metres, or about 14¾ feet, and the total volume of water to be drained, at over 7,500,000,000 cubic yards. A steam machinery of less than 10,000 horse-power could expel the water within the embankment within two years. The new province of Zuyder-Zee will be the tenth province of the Kingdom, and will cover an area of 753 square miles, a little less than two average counties of Ohio. It will constitute about the one-eighteenth of the surface of Holland. It will be a welcome addition to the productive area of this industrious Kingdom, and will add greatly to the national wealth and resources.—*Bulletin of the Bureau of Agriculture.*

Another Ship-canal Project.—An important water cut-off is suggested by the leading commercial journals of Europe at the present time. It is a ship-canal from Bayonne, in the Bay of Biscay, through Toulouse to Ayde, which is two miles from the Mediterranean. This improvement, if constructed, would make almost a bee-line from Plymouth, England, to Malta, and save the long run down the coasts of Portugal and Spain. This at present amounts to some hundreds of miles. When all the advantages of the projected improvement are carefully considered, its paternity can readily be fixed. It is England that would profit most from such a shortening of the road to India. With a ship-canal across the southern end of France, vessels could leave Liverpool or any other English port, pass readily and quickly into the Mediterranean, and from that sea by the Suez Canal into the Arabian Sea, and thus reach her possessions in India.—*Times.*

Opening Central Africa to Commerce.—One of the novel engineering schemes at present provoking discussion, contemplates the formation of a canal for commercial purposes from the mouth of the river Belta, on the Atlantic, in the neighborhood of Juby and Cape Bajador, opposite the Canary Islands, to the northern bend of the Niger at Timbuctoo, a distance of 740 miles. Such a highway would open up the African Continent to the world, and it is believed that no formidable obstacle opposes the construction of the work, but that the great Desert of Sahara favors it. For 630 miles of the distance there is a large hollow, supposed to be 250 feet below the level of the Atlantic Ocean, which was probably at one time covered by the sea. The low country is separated from the coast by a broken ridge of about 30 miles, through which the river Belta runs for 25 miles, so that all that would be necessary to reach it, would be to deepen the channel of the river, cut through the ridge, and let the waters of the Atlantic fall into the vast arid basin. In this way a fine sheet of water would be formed, the climate would be improved, the country would become more fertile for pasturage and agriculture, and commerce would be carried into the heart of Africa. The plan is that of Mr. Donald Mackensie.—*The Engineer.*

Ancient and Modern Guns.—The contest between guns and armor continues to excite the liveliest interest among European nations. The great arsenals are vieing with each other in the production of mighty cannon which will be able to send a projectile weighing many hundreds of pounds through iron obstacles of almost incredible thickness, or of iron targets which shall be able to resist the heaviest bolts that can be forged. The English are now rejoicing over the successful trial of the new 80-ton gun, which can throw a projectile 16 inches in diameter a distance of seven or eight miles, and pierce the sides of the strongest man-of-war afloat at a closer range. Next we shall probably hear of the construction of some unwieldy floating battery specially designed to carry armor capable of resisting the tremendous impetus of a shot from this latest engine of war; and then the forges will glow with mountains of incandescent metal until a gun of still greater dimensions and power is produced. As there appears to be no limit to the size of cannon, it seems probable that the victory in the struggle between guns and armor will finally declare itself in favor of the former, or that it will, at all events, be necessary to construct vessels of the monitor type only, which present the smallest possible target to the fire of the enemy. This is a question, however, which must be left to the Armstrongs and Whitworths of the future to answer. In the meantime it is interesting to remember that the monster cannons now in existence are simply examples of the manner in which history repeats itself. Four centuries ago, in the year 1478, the Turks erected a battery of guns against Scutari, the largest of which was capable of throwing a stone shot 32 inches in diameter, and weighing 1640 pounds; whereas the projectile of the English 80-ton gun weighs only 1250 pounds. It is evident, moreover, that these enormous guns were of practical service, for is it recorded that 2534 rounds were fired from them in thirty days. At the castle of Asia, on the Dardanelles, there still exists a battery of bronze cannons, some of which have a bore of 28 inches in diameter. When the British admiral, Sir John Duckworth, forced the passage of the Straits, in March 1807, one of his ships was struck by a huge stone bullet thrown from one of these guns, and it is said that the missile made so large a hole in the side of the vessel that the captain, when he looked over the side to see the extent of the injury, was surprised to see two of his sailors thrust their heads through the aperture at the same instant. The Royal George, whose name is familiar to every reader of Cowper's poetry, was one of the ships injured in this encounter. The great gun of Beejapore, with a calibre of 28 inches, is another instance of what gun-founders could accomplish more than three centuries ago. This weapon was last discharged, it is said, during the eighteenth century, on the occasion of a visi from the Rajah of Sattara. The shot weighed more than a thousand pounds. The Tzar Pooshkar, or great gun of Moscow, has a bore of 35 inches in diameter, but has never been fired with shotted charges, and we think that few persons would be anxious to make the experiment now. There are many other great guns famous in history, but those we have mentioned are sufficient to prove that, in the matter of capacity, at least, the guns of the present are no more remarkable than the guns of the past.—*New York Post.*

A New Steamship Line.—The Inman Steamship City of Limerick, Capt. Jamieson, has made her first voyage from Liverpool to Philadelphia. The Inman Company has decided, it is affirmed, to establish a regular line between Philadelphia and Liverpool, to be composed of the steamships City of Limerick, City of Bristol and City of New York. Others will be added as the necessities of the trade may demand.

Direct Line of Railroad from Boston to the Coal Fields. A preliminary meeting of the presidents and others interested in the construction of a shorter line of railroad between Boston and the Pennsylvania coal fields was lately held in New York, for the purpose of considering a plan for the construction of a shorter line of railroad from the Pennsylvania coal fields to Boston by way of Albany. J. W. Van Valkenburgh, president of the North Adams and Albany road, presided. The State of Massachusetts, he said, owns the Hoosac Tunnel, which is four and three-quarters miles through, and fifteen miles beyond the western end of it to the State line, and also owns the railroad from North Adams to Greenfield at the end of the tunnel. This road is known throughout the State as the Commonwealth road. The plan proposed was to connect North Adams with Albany by a direct road through the Hoosac Tunnel, and then by the construction of short connecting lines, inviting railroads already in existence to form a direct line from the Pennsylvania coal fields by way of Carbondale, Hancock, Shavertown, Marketville, Mooreville, Middleburg, Albany, North Adams, Greenfield, Fitchburg, &c., to Boston. By the construction of this road it is claimed that the devious route of the Troy and Boston road would be avoided, as well as the heavy grades which affect the present coal roads. The construction of the Albany and Greenbush bridge, he added, made the project more feasible, as a through route could thus be constructed that would do away with the necessity of breaking bulk, besides saving time and distance in the transportation of coal and oil. The meeting was very harmonious, all the persons present apparently approving of the object of the meeting.

British Railway Statistics.—The following is a summary of the leading features of the railway system of Great Britain at the close of the year 1874, compiled from recently published official figures:

It appears that a total sum of £609,895,931 was expended on 16,449 miles of railway, of which 8749 were laid with two or more lines of rails, and 7700 were single lines, at a cost of about £37,000 a mile. There were 11,935 locomotive engines, or about one to every mile and a half, and 379,899 vehicles, or about twenty-three per mile, besides great numbers of wagons, of which there is no means of forming an estimate, belonging to traders and companies other than railway companies. By the running of trains over 200,484,263 miles £56,899,498 were received during the year, of which £31,647,517 were expended in working and maintenance, and £25,251,981 remained as net profit, so that 56 per cent. of the gross receipts were expended in earning them. There were 477,840,411 passenger journeys, besides the journeys of 493,957 season and periodical ticket holders; and 188,538,852 tons of goods and minerals, besides a large amount of live stock, were conveyed.

The more prominent facts connected with the traffic working in 1874 as compared with 1873 were as follows: There was an increase of gross receipts amounting £1,224,077, but also an increase of working expenses amounting to £1,587,405. There was an increase of £126,077 in the receipts from first-class, of £114,463 from second-class, and of £596,017 from third-class passengers. There was an increase of 964,005 in the number of first-class, of 1,935,535 in the number of second class, and of 19,620,683 in the number of third-class passenger journeys. There was an increase in the receipts of goods, minerals, &c., of £184,354.

The total number of miles of railway open and working in the British Empire to the most recent dates attainable, mostly December, 1874, is, in the United Kingdom, 16,449 miles; total of Colonial Empire of Great Britain, 12,158; total in British Empire, 28,607 miles.

The Schröder Air-ship has come to an untimely end. A strong gale in Baltimore completely wrecked it..... *A Recent Band-saw Machine* has a rotating steel tire on the upper wheel, to act as a gradual brake on the stoppage of the

machinery or the retarding of the blade..... *An improved* system of manufacturing hexagonal nuts cuts them from a bar so serrated by dies, with alternating hemi-hexagonal recesses and projections, as to allow of the nuts being cut apart by a single diagonal cut, without any waste of material.... *Steam on the Canal.*—The Ludlow Patton has made a round trip between Georgetown and Cumberland, including lockage, in 115 hours. Her average fuel per trip has been four and a-half tons, and the repairs to motive power have cost but ninety cents..... *Steam on the Highway.*—Wisconsin offers $10,000 reward for a successful road locomotive. ... *Sixty-foot Rails.*

The Edgar Thompson Steel Works are making sixty-foot rails, thus saving two crop-ends, cost of laying, and wear and tear of rails and rolling stock, and strain on bridges..... *Compressed Air Engine.*—A new motor power uses highly compressed air, used continuously, being heated in one cylinder and cooled in another..... *About* 240,000 "Bath bricks" are annually imported into the United States from Bridgewater.

MINING, METALLURGY, MINERALOGY.

Coal Trade of the United States.—The *Engineering and Mining Journal*, which has devoted special efforts to obtain trustworthy statistics of the coal trade of this country, affords us the following facts and estimates. Although it is yet too early to state with accuracy the amount of the coal production of the United States for the year 1875, sufficient information is at hand to warrant the assertion that the aggregate production of coal has increased, notwithstanding the continuance of an unparalled depression in every branch of business during the entire year. In 1875 the production of anthracite varied but little from that of the previous year, although the proportionate production of the Wyoming region is greatly increased—a result attributable to the prolonged strike of the miners, which affected the Lehigh and Schuylkill regions more severely than the first-named region. The following is an approximate estimate of the production of anthracite for the year just past, as compared with the ascertained output of 1874:

Anthracite.	1874. Ascertained.	1875. Approximate.
Wyoming region, in tons of 2240 lbs	10,204,764	11,550,000
Lehigh " " "	4,712,280	3,475,000
Schuylkill " " "	6,715,074	6,400,000
Sullivan " " "	36,261	16,000
Total.....	21,667,381	21,441,000

There has been from year to year a steady increase in the production of bituminous coal. This increase has been made mostly in the West, but the Clearfield region of Central Pennsylvania has made great progress within the past year, and its coal now comes to the front as a formidable competitor, both of Cumberland and anthracite, in the markets of the East.

The Director of the Mint, in his Annual Report to the Secretary of the Treasury, estimates the domestic production of the precious metals for the fiscal year ending June 30, 1875, to be as follows:

Arizona	$ 1,000,000
California	17,000,000
Colorado.....	5,472,000
Idaho	2,500,000
Montana...	4,119,852
Nevada.....	31,795,193
New Mexico	1,000,000
Oregon.....	1,665,000
Utah	6,844,570
Wyoming Territory.....	250,000
Washington Territory.....	300,000
Total	$71,946,615

Of this amount the director estimates that about $40,000,000 was gold.

Wealth of Lower California.—From the lately published report of the survey of peninsular California, made by the United States steamer Narragansett, it would appear that the mineral wealth of this country is wonderful, embracing rich deposits of silver, gold, iron, copper, antimony, alabaster and salt. At one place (Triunfo) a silver mining company is producing bullion to the amount of $50,000 a month. At Purgatoria and Providencia, copper mines are being actively worked, and are yielding large quantities of rich ore, which is brought to the sea-shore on pack-mules, and shipped to San Francisco and to Europe. At the Island of San Marios there is affirmed to be a rich mine of alabaster, capable of yielding an immense profit if properly worked. At Carmen Island is a salt deposit a mile and a half long and half-a-mile wide, and of unknown depth. The salt is pure and beautifully crystallized. Another source of wealth is the guano islands, especially the Isla Raza, from which 10,000 tons of the fertilizer have already been taken. It is computed that as much as 60,000 tons more lie upon a strip of shore three-quarters of a mile long and half-a-mile wide. The presence of fossil shells of modern species, at elevations above 1000 feet above the present sea-level, indicate that a greater portion of the peninsula is, geologically, of comparatively recent origin.—*American Exchange and Review.*

The After-damp in Coal Mine Explosions.—Mr. J. W. Thomas, of Cardiff, Wales, in a recent article on "Explosions in Coal Mines," published in the *Iron and Coal Trades Review*, ably advocates the opinion that the deadly effects of the *after-damp* are to be ascribed, not to the suffocating influences of carbonic acid gas and nitrogen, as is generally believed, but by the actively poisonous influence of carbonic-oxide, which, he holds, is produced in large quantities by fire-damp explosions in the mines. The following statement is a summary of the arguments he adduces to support that view: Some eighteen months ago, when experimenting upon the gases inclosed in South Wales coal, I exploded small quantities of marsh gas (fire-damp) mixed with oxygen in sufficient proportion for complete combustion, and found that carbonic acid and water are not the only products formed, but that, with the smallest volume of air capable of affording combustion, little or no carbonic acid and water were formed, the resulting gases consisting of carbonic-oxide and hydrogen. In all cases where the proportion of oxygen is insufficient for complete combustion, a large quantity of carbonic-oxide is generated. In the event of a strong blower breaking into a heading, it is only reasonable to suppose that much more of the space traversed by the flame of the ignited gases will be occupied by mixtures containing less than ten volumes of air, and that, in consequence, an immense quantity of carbonic-oxide will be generated. In fact the whole of the carbon of the marsh gas is converted into carbonic-oxide when the oxygen present is insufficient in quantity to unite with the hydrogen, and thus large volumes of hydrogen are set free. When the fire-damp is mixed with 9·5 parts of air, carbonic acid and water are, for the most part, formed. It will be readily understood, however, that in every instance of an explosion, mixtures of fire-damp and air will exist in every possible proportion; that is to say, from 1 part of air with 100 of fire-damp, to 1 of fire-damp with 100 of air. The air in the galleries and headings of a coal mine, likewise, is charged with floating particles of coal dust, incidental upon the process of working. These floating particles, at the moment of explosion, become ignited, and doubtless aid in robbing the atmosphere of a considerable portion of its oxygen. It will therefore appear evident that, up to the explosive limit of a mixture of air and fire-damp (probably 13 parts), very little oxygen will remain unconsumed. Were it possible for the fire-damp to be present in a mine intimately mixed with ten volumes of air, the actual force of the explosion would be vastly greater than appearances generally indicate, but the fact (corroborated by Dr. Meyer, of Germany), that carbonic-oxide is present in the after-damp in considerable quantity, would, I think, naturally lead one to assume that, although more force would be exerted through the combustion of a mixture of ten volumes of air with one of marsh-gas, the effects of the after-damp upon those removed from the scene of the explosion, would not be so deadly as they manifestly are.

The Problem of Machine Puddling.—Mr. I. Lowthian Bell, the eminent metallurgist, and ex-president of the British Iron and Steel Institute, has just published an interesting record of the facts and observations accumulated during his recent visit to this country, and a thorough inspection of our iron manufactures, under the title of "Coal and Iron Mines and Iron Works in the United States." We extract therefrom the following brief paragraph covering his allusions to the problem of mechanical puddling in its American aspects, viz:

"After the interest manifested by the Iron and Steel Institute in mechanical puddling and the desirability of its substitution for that performed by manual labor, I regret that I am unable to give a very satisfactory account of the progress of the former in America. With the exception of one or two single machines, the introduction of the so-called Danks' method of mechanical puddling has been confined to four works, and in two of these the furnaces have been removed owing to the constant interruption to the process from the wear of the machinery, &c.

"The two establishments at which this system is still in use are the Railroad Mill, at Cincinnati, under Mr. Danks' own superintendence, and the mill of Messrs. Graff, Bennett & Co., at Pittsburgh. Mr. Danks himself is as confident as ever of the ultimate success of his invention, and of this Mr. Bennett and his manager, Mr. Williams, are equally sanguine. At both places during my visit the work was going on to all appearance in a very satisfactory way, but it has to be remarked, that in neither were the furnaces worked during the night. My own impression is, that enough has been seen of rotatory puddling to enable us to predict with confidence that it will ultimately be achieved. This may be the result of considerable modification of the apparatus described by Mr. Danks at the Dudley meeting, but the fact will remain that the superseding of hand puddling by mechanical means, when it is accomplished, will owe much to this gentleman for the assistance he has rendered, not only in perfecting the furnace itself, but to the other appliances required in manipulating such large masses of the product as those dealt with in his originally designed piece of apparatus. It is only right to add, that those entrusted with the management of the works of Messrs. Graff, Bennett & Co., have, I believe, afforded important service in the progress which has already been accomplished in this important branch of our art."

On the night turn, December 31, 1875, and January 1, 1876, there was blown at the Bethlehem Iron Company's Bessemer Steel Works, what is believed to be the largest heat of steel ever made in this country. This heat was the first in the new year, and weighed in steel ingots eighteen thousand five hundred and fifty (18,550) pounds. This was blown in an ordinary "five-and-a-half-tons" vessel. The blast pressure was twenty-four pounds, and the "blow" occupied twenty-one minutes.—*Engineering and Mining Journal.*

On Wednesday, December 29th ultimo, the first Bessemer steel rail was rolled at the lately completed Bessemer Works of the Lackawanna Iron and Steel Company, at Scranton, Pa. This makes a total of ten Bessemer steel establishments that are now completed and in operation in this country, the total annual capacity of which exceeds 400,000 gross tons of ingots. The Vulcan Iron Works at St. Louis will next summer increase this capacity to 500,000 tons.—*Bulletin, American Iron and Steel Association.*

American Spiegeleisen.—Heretofore the New Jersey Zinc Company, with its three little furnaces at Newark, New Jersey, has made all the spiegeleisen that has been made in this country; but late in 1875 the Bethlehem Iron Company and the Cambria Iron Company commenced to make spiegeleisen from Spanish ores, and the Woodstock Iron Company, from Alabama ores. We understand that all of these experiments have been successful. We add the important information that the Cambria Iron Company, and possibly other companies, will certainly make spiegeleisen in 1876 from Pennsylvania ores.—*The Bulletin.*

Basacoit and Roche's Steel Process.—This process consists in the conversion into steel of a mixture of pig iron and ore at a low temperature, at the expense of the carbon contained in the pig iron. The mixture is run in the liquid state into iron crucibles, where it is left to cool, being afterwards exposed to the heat of a cementing furnace brought to a cherry-red. The result is a double decomposition, the oxygen of the ore combining with the carbon of the pig iron, while the latter is brought to the condition of steel by the excess of carbon, and iron from the ore.

Iron and Steel by the Knowles' Process.—In a communication to *Iron* respecting the "Production of Steel from the Ore," Sir Francis Knowles says: "It occurs to me that your readers may wish to know in what manner I propose to practically effect the fusion of such steel in large quantities so as to evade the cost of melting once or oftener in pots. I shall suppose for this purpose that we have obtained our metallic sponge from ore originally free from phosphorus, and calcined, if need be, to expel sulphur. The reduction to this state may be effected by charcoal, but I much prefer, when it can be had, reduction by a current of light or heavy carburetted hydrogen gas, as this reduction takes place at a much lower temperature, and is very complete. (Properly managed, the gas given off in this reduction ought, after passing through cold water, to be pure carbonic-oxide). This sponge is then to be ground up with the proper flux, and compressed into small cakes. A basis of richly carburetted pure pig-iron in fusion having been run out into the converter, the current of burning pyrogen gas, as described by me in former papers, is to be let on for a few minutes, after which the prepared ore is to be gradually added to the bath, the gas current being continued until the exact degree of cementation of the metal required in the aggregate is attained. The weight of sponge being known, and the degree of its carburation, if any, as well as that of the original metal bath, the proper proportions are easily attained. If the flux have been well adjusted, the cinder or scoria ought to be a perfect glass, free from metallic oxide (save where manganiferous materials are present), and suitable for glass-making. The heat evolved by the complete combustion of pyrogen is sufficient for the fusion of the prepared ore in a proper furnace without metal; but I hesitate to advise it, because, as it seems to me, it would render more difficult the due degree of cementation, and might corrode the lining of the furnace. In all cases, the finery, furnace, or converter, must be gradually heated up to the point at which the bath is to be run in, as sudden contractions by heat may injure the lining. The ores which I prefer are the best magnetic or spathose, well calcined, and the same may be generally said as to the metal of the bath; but a splendid basis may be obtained in metal produced from pure brown hæmatite, such as the ores of the Duc d'Arenberg, which are rich in oxide of manganese.

"In the above I contemplate the production of a high-class workable steel, such, for example, as would require, in the old method of cementation, Russian or other charcoal bars at £20 a ton and upwards. If to this we add the cost of cementation and melting in pots, we get a pretty good margin for the above operations, raw materials included. This steel may be used also for casting articles in moulds, as proposed in my previous letter. Axes so made could be worn down to the 'eye' itself, to the joy of the backwoodsman."

A New Safety Tuyere for Blast Furnaces, etc.—Serious accidents from explosions occasioned by leaky and defective water-tuyeres are of such frequent occurrence, as to render any claims for substantial improvement in their construction worthy of careful examination. For this reason the description of the open spray tuyere, contrived by Mr. Lloyd, of Wednesbury, is herewith appended. In this device the cooling is effected by the introduction of a perforated pipe within the hollow walls of the tuyere. Water being admitted into this pipe under a moderate head, a number of little jets of water play on the heated surfaces of the casing, and, even when the tuyere is exposed to the highest temperature, by their partial or entire evaporation, effectually reduce its temperature and keep it from being overheated. The water passes off by a pipe from the lower side of the tuyere, and is no warmer than the waste water from the ordinary water-jacketted or coiled tuyere. The back part of the casing is open to the atmosphere.

In its non-liability to originate serious explosions, this invention is claimed to possess decided merits, viz: In the first place, a jet of water thrown on a heated surface will cool it more effectually than the mere circulation of a current of water through a body of metal. In the second place, even assuming the end of the tuyere to be melted off, no considerable body of water could find its way into the furnace, but only a few sprays, which would harmlessly dissipate into steam, and prevent the melting from going further. The fact of the outer end of the tuyere being left open, finally, also prevents the occurrence of accident from the rapid formation of steam in the casing of the tuyere itself, since this is free to dissipate as fast as it is formed.

The Lloyd spray-tuyere having demonstrated its efficiency by a practical test of over a year at the Darlaston Iron and Steel Company's furnaces, is about being largely introduced, if report is to be relied on. In further elucidation of its merits, our informant concludes with the statement that it is durable, and has the advantage of being safe to work with until it can be conveniently replaced, even after the casing has become defective. It is, however, as offering a reasonable protection against one of the serious dangers that beset the furnace-tender, that Mr. Lloyd's invention deserves the most attention. If it proves to be, indeed, a safety tuyere, it will take rank as an invention which deserves well of the metallurgical community.

The plant for two charcoal blast furnaces has been shipped complete from England to Japan. They are provided with all the modern improvements.

Tin in Malacca.—A writer in the London *Times* affirms that the district of Laroot, in Malacca, is so enormously rich in tin (besides gold, silver, copper, cinnabar, lead, etc.), that it only requires a condition of peace and security to have 100,000 miners speedily at work, producing tin in sufficient quantity to inundate the markets of Europe and America.

A New Mineral.—Prof. J. W. Mallett describes in the *Journal of the Chemical Society* a new molybdo-arsenate of lead, from Mexico, for which he proposes the name of Achrematite. The mineral is compact, and here and there indistinctly crystalline. Color, liver-brown; lustre, between resinous and adamantine; sp. gr., 6·17; hardness, 3·5.

CHEMISTRY, TECHNOLOGY.

Metallic Gallium.—The last addition to the list of elementary substances, which its discoverer, M. Lecoq, has patriotically called Gallium, in honor of his native country, has at length been obtained in the metallic state. We learn that at one of the late sittings of the French Academy, Prof. Wurz submitted a specimen of the metal for inspection, concerning which, and the process by which it was obtained, the following information is given: It is said to rank in appearance and lustre between platinum and silver. It was obtained in the metallic state by the galvanic-decomposition of its ammoniacal sulphate, the precipitate being submitted to the burnisher. It may be of interest to allude to the fact, that this new element —the existence of which now appears to be established—was first detected in a specimen of Spanish zinc-blende (zinc sulphide) from Pietrafitte. From its association, therefore, it is not surprising that the discoverer of gallium found it to possess such a close relationship with zinc, that the separation of the two metals was a matter of great difficulty. After much investigation, it was found that the separation could be practically effected by the use of carbonate of soda, which, when added to a solution containing the two metals, precipitates all the gallium and but little zinc. The new metal appears likewise to have certain chemical analogies with aluminium, inasmuch as its sulphate will combine with alkaline sulphates giving rise to an *alum*, which crystallizes in cubical forms.

Dr. James Edmunds, in the *Chemical News*, called attention to the fact that at a certain stage in the incineration of bread, the beautiful ultramarine blue is formed. He has satisfied himself by analysis that this phenomenon is not due to the presence of copper, and suggests that the supposed use of copper salts for adulterating bread which is often referred to, may sometimes have been erroneously inferred from the occurrence in bread-ash of this coloration.

Spontaneous Combustion of Coal.—A recent discussion before one of the leading chemical societies of England, brought to light the fact that of the whole number of vessels carrying 500 tons of coal, or upwards, that sailed from the United Kingdom, during the first nine months of the year 1874, for ports south of the equator, the number of casualties from spontaneous combustion was 50, or about 4 per cent. of the whole number. The statistics show further that these casualties were not confined to one kind of coal, but were common to most all of the varieties shipped. One of the reasons alleged for the notable increase of this species of accident is that, owing to the extraordinary demand for coal and the high price of labor, the coals are not so carefully freed from pyrites as was formerly the case. The theory of Richters, who affirms that the absorption of oxygen by coal is the cause of spontaneous firing, by producing the slow combustion of the organic constituents of the coal, was brought forward, and the opinion was pronounced that the phenomenon could be most satisfactorily explained by the presumption that the heat which gives rise to spontaneous combustion is developed by the oxidation of iron pyrites, as well as by the oxidation of the carbonaceous constituents of the coal; and that in the holds of vessels, where large cargoes of coal lie unventilated, the heat accumulates, and may ultimately acquire sufficient intensity to set fire to the cargo.

Unhealthful Trades.—We give in what follows an abstract of an instructive lecture lately delivered before the Society of Arts, by Dr. B. W. Richardson, on "Industrial Pathology; or, The Influence of Certain Injurious Occupations on Health and Life":

There are, said the lecturer, seven active causes producing disease amongst the working classes—first, noxious inhalation of dust and gases; second, exposure to soluble chemical substances; third, mechanical impact of foreign bodies; fourth, physical injuries from unnatural postures, &c.; fifth, exposure to damp or impure air; sixth, contact with organic parasitic forms; and seventh, excess of muscular work, &c. Turning his attention in the first instance to the injury caused by the inhalation of various sorts of dust, Dr. Richardson alluded to the growth of oidium on the vine, which growth was checked by the blowing of sulphur-dust on the plant. Oidium was described as a white parasitic fungus, which appeared not only on the vine, but also in the throats of persons suffering from diphtheria. Ammonia often proved injurious to hatters. The vapor of turpentine produced a specific form of disease, and was more injurious to house-painters than the lead to which their peculiar complaints were commonly attributed. Sulphide of carbon was useful as an anæsthetic agent, but produced disease and insanity when inhaled for any time by men who used it in their occupations. The fumes of nitric acid affected furriers deleteriously. The vapor of chlorine affected bleachers injuriously at first, but on continued use became innocuous. Aniline produced two distinct forms of disease—one neuralgia, the other ulceration, and when the inhalation resulted in death, the flesh was found to be of an aniline or mauve color. Nitro-benzine vapor produced headache, and the vapors of metals caused various diseases of the lungs, brain and stomach. The remainder of the lecture went to show that apoplexy, paralysis, insanity and various other serious diseases, were producible in artisans by contact with injurious substances and vapors, especially that of lead, which affected not only the working-man using it, but also his offspring. Cleanliness and care, the speaker affirmed, would greatly mitigate this mischief, but still the startling fact remained, that amongst those workmen who were exposed to the vapors of lead, the deaths were 38 per cent. in excess of the ordinary mortality.

Dr. R. had no radical remedies to suggest for the majority of his illustrations, and contradictory as it may appear, it is unfortunately true, that it would have made no sensible difference had he done so, since, on the principle possibly that familiarity with danger breeds indifference to, or contempt of it, experience has demonstrated that, as a class, no reforms are more difficult to introduce than remedial measures of this character.

The manufacture of a barrel of petroleum into a fixed-gas can be accomplished at a less cost than into refined oil. Numerous works for this purpose are now in operation, and more are being erected, while the cheapness with which they can be built and operated puts gas-light within the reach of the smallest communities, instead of confining it to the cities, as is, and must be, the case with coal gas.—*Anthracite Record.*

Water-proofing Recipe.—It is known that the bi-chromate of potassa, under the influence of the sunlight, has the property of rendering glue (or gelatin) insoluble in water. By taking advantage of this circumstance, paper and fabrics of cotton, linen, silk, etc., if once coated with this insoluble glue, become decidedly impervious. To render the glue insoluble, it is sufficient to add to the water in which it is dissolved one part of bi-chromate to fifty parts of glue. The addition is made at the moment when the liquid is to be applied, and may be conducted in the full daylight. The Japanese, it is said, make their umbrellas with paper prepared in this manner. We may add that the same compound will be found to afford an excellent recipe for cementing glass. Valuable objects of glass, which would be disfigured by the use of common cement, can be satisfactorily repaired by the application of the chromated gelatin mixture, with the aid of several hours' exposure to sunlight. It is suggested that microscopic object-glasses could be better fastened with this than with black asphalt.

Electroplating with Bismuth.—A galvanic deposit of bismuth on metal surfaces may be obtained, according to Bertrand, by employing the following recipe. For this purpose he employs the double chloride of bismuth and ammonium—a white, crystalline compound, very soluble in water, and not precipitated by a slight excess of hydrochloric acid. He recommends that the operation be conducted in the cold, and with a solution containing about 250 grains to the pint of water. Precipitation is easily effected with a single Bunsen element; with a Daniell's it is slower. When the operation is finished the objects—of brass or copper—will be found to have a blackish tint on the surface, below which, however, the bismuth, which adheres firmly, will be found with its characteristic lustre, midway between that of antimony and old silver. The deposit takes a fine polish. In an analogous manner the double chloride of antimony and ammonium affords a galvanic deposit of antimony.

The above possesses the interest which attaches to an item of scientific progress, but it seems scarcely probable that any process of electroplating with either of the metals named therein will ever achieve a technical importance, inasmuch as, without possessing any peculiarly valuable qualities, neither of them are as permanent when exposed to atmospheric influences, nor as resistant to chemical agents, as the silver or nickel surface obtained by galvanic deposition.

MISCELLANEOUS.

Rewards to Scientific Investigators.—The presentation of the following marks of distinction by the Royal Society of London took place at the recent anniversary meeting of the Society, viz.: the Copley medal to Prof. A. W. Hofmann, the eminent chemist, for his numerous contributions to chemistry, and especially for his researches on the derivatives of ammonia; a royal medal to Dr. Thomas Oldham, Superintendent of the Geological Survey of India, for his long and important services in Geology; while the third was awarded to Dr. William Crookes, for his various chemical and physical researches, with especial reference to his discovery of thallium, his investigations of its compounds and determination of its atomic weight, and for his recent discovery of the repulsion induced by radiation.

The Transit of Explosives by Sea.—The terrible circumstances which led to the discovery of the diabolical plot to destroy the steamship "Mosel" will long be remembered with horror, and yet, if we may credit our excellently well-informed contemporary, *Iron*, such carelessness—shall we not rather say criminal recklessness?—in the shipment of explosive and inflammable substances, on the part of shippers, is occasionally brought to light, as to render it more than probable that many a ship is sent to sea freighted with a cargo as terrible as the infernal machine of Thomassen. The facts which our contemporary adduces are apparently well substantiated, since the cases are particularized, viz.:

"The *Strathmore* left London with ninety souls on board and several tons of gunpowder, and packed with various goods of a highly-inflammable description. After getting out to sea she was neither spoken nor heard of, and has, most likely, been blown into matchwood. From a statement issued by a colonial Underwriters' Association, we learn that the custom is to stow gunpowder in ocean-going ships, passenger or other, among the ordinary cargo. In one case the Association mentions, some two hundred barrels were separated from a passenger's cabin only by a three-quarter-inch bulkhead. The case of the *Altcar*, however, which arrived at New Zealand last August, 'out-Herods Herod': Four hundred kegs of powder were placed in this vessel's hold with a general cargo, which comprised, among other inflammable matters, oil, paint, spirits and lucifer matches. Among these there was a

quantity of iron, by the dislodgment of which during the severe weather the ship encountered, or in some other way, eight kegs and three cases of powder were smashed, and their contents scattered throughout the whole of the inflammable cargo."

If there ever was a subject demanding a prompt and thorough legislative investigation and radical reform, it is the code of laws or regulations which makes such blood-chilling occurrences as the above possible; and in this connection a question of peculiar significance suggests itself, which we would be pleased to be able to answer affirmatively, viz.: Are our shipping regulations more stringent in their provisions, and are these more scrupulously enforced, than those of Great Britain?

Geological Survey of the Territories.—The results of the geological and geographical survey of the territories, conducted during the past season by Messrs. Hayden and Powell, under the direction of this department, will, it is believed, equal in interest and importance those of any previous year. The survey under F. V. Hayden continued its labors of the two preceding years in the Territory of Colorado. The survey of the southern and southwestern portions of Colorado has been completed. The total area surveyed was about 30,000 square miles, portions of which were rugged. The exploration of the remarkable pre-historic ruins of Southern Colorado, glimpses of which were obtained the preceding season, was continued with great success. The survey under J. W. Powell continued the labors of the preceding year in the Territory of Utah. Nearly 10,000 square miles of country were surveyed during the season just closed. The whole area surveyed during the season is classified by Mr. Powell as follows: Pasture lands, 50 per cent.; timber lands, 9 per cent.; mineral lands, 4 per cent.; irrigable lands, less than 1 per cent., and the remainder, over 36 per cent., waste lands. —*Annual Report of Secretary of Interior.*

Foreign Exhibitions in 1876.—In addition to the great exhibitions at present in progress at Santiago, Chili, and at Melbourne, Australia, the following list includes a few of the special events that are impending:

An exhibition of objects of art and art industry will be held at Munich, from July 1st to October 15th, by the Munich Society of Arts, in commemmoration of its twenty-fifth anniversary. German and Austrian exhibitors only will be invited to participate.—An International Exhibition will be opened at Brussels on June 15th, devoted specially to the display of devices, appliances and processes for saving life, under the following classifications, to wit: (1) Life-saving apparatus—fire; (2) ditto—water; (3) ditto—accidents, railway, tramway and street; (4) treatment of wounded in war, removal of dead; (5) public health; (6) sanitary and life-saving regulations in trades and professions.—On the 19th and 20th of January, an exhibition of objects and paraphernalia pertaining to cookery, commenced in Berlin. Gold and silver medals will be awarded, and the display will be closed by a lottery of the objects exhibited.—The *Société Industrielle de Mulhouse* will celebrate its fiftieth anniversary by holding an exhibition of the industrial resources of Alsatia. The exhibition will be opened in May next.—In February next the Bengal Photographic Society will open a photographic exhibition at Calcutta.

Mid-ocean Telegraph Stations.—It is reported that a number of foreign naval powers are directing their attention to the practicability of establishing telegraph stations in mid-ocean, by which messages can be sent from any part of the sea along the line of the cable to the terminal points on shore, and *vice versa*, so that communication with iron-clads, mail steamers and other vessels when out at sea, may be established. The invention consists of a hollow sectional column, with a base plate attached by ball and socket-joint, which column is lowered into the water, and anchored rigidly to the ground. The branch cable is coupled to the main cable, and carried along the column to the surface of the water, to be there connected with instruments on board the vessels. By this invention it is proposed to control naval and strategetical movements, while a ship in distress could communicate her exact position, the nature of her disasters, and thus procure assistance.

Russian Flax Trade.—Russia is not only the largest producer of flax, but also that her products alone exceed those of all other countries put together. Notwithstanding this enormous production of the raw material, the manufacturers of linen fabrics are far from occupying in the textile industry of the country that preponderance which it would seem they ought to have acquired. In fact, the cotton mills, and those for the manufacture of stuffs which have this substance as their base, are much more numerous than the flax-works. There are 759 cotton-mills, employing 122,000 hands, while not more than 111 flax-works exist, giving work to only 2000 hands. The Commission attributes this state of things, in the first place, to the defective means adopted by the growers for gathering in the plant itself, and to the rude appliances still in vogue for its preparation; and, in the second place, to the inconvenient situation of the works, which are often very far from the place of production. The Commission recommends that good methods of cultivation be popularized; that the improved machines and processes employed in other countries for treating the stalks be introduced into Russia; and, lastly, that money inducements be offered for the establishment of new works in the centres of production.—*Scientific American, Supp.*

BIBLIOGRAPHICAL NOTICES.

ANNUAL REPORT OF THE CHIEF OF ENGINEERS TO THE SECRETARY OF WAR, FOR THE YEAR 1875. In Two Parts. Washington: Government Printing Office.

We have before us the two 12mo. volumes bearing date 1875, and respectively 990 and 1254 pages, constituting the report of the Chief of Engineers, General A. A. Humphreys, to the Secretary of War. An extended work of this kind contains so much material of no general interest, and so much worthy of more than a passing reference or hasty review, that we shall not attempt the latter, but will better serve the public good by giving, from time to time, excerpts and synopses of the reports on special works. Our leading article, upon the improvement of the mouths of the Mississippi River, is prepared largely from material forming the *appendices* of this report.

Tests in Torpedo Defence—1875.—The trials designed to develop the best system of submarine defences for our harbors, have evolved the laws governing the use of torpedoes. Major Abbott has framed a formula representing satisfactorily the relations between the buoyancy, the area of cross-sections, the form of the surface, the velocity of the current, and the angular depression of the torpedo. Thus are avoided, in any given harbor, undue expense from excessive size, and undue depression from deficient buoyancy. . . . It has been shown that no danger of detonating a charge of dynamite, by the shock from a neighboring mine, need be feared. As to endurance, torpedoes have been kept submerged a year, and in no instance has the adopted pattern failed. . . . The Leclanché battery has proved superior to all others for firing and signals . . . Dynamite has been found superior to all other explosives tested. . . . There were performed interesting practical tests for determining the force requisite to destroy a first-class iron war vessel, with double cellular bottom of most approved type. One target was of wood—being a raft of oak and spruce timber in equal proportions—15 x 15 x 2 feet; bolted strongly and carrying 8 gauges. This, not opposing sufficient weight, was anchored down by heavy mushrooms, and was finally torn asunder by 10 lbs. of dynamite, hung 10 ft. below its centre. A second target was of 20 x 20 x 3 feet; and designed to represent the bottom of a first-class iron-clad. It was divided into compartments, 4 x 4 feet, by stout angle frames; was of iron much better than any used in ship-building; carried 16 gauges; and was held down by sixteen 1000 pound anchors. Three shots have been fired. The last, 40 pounds of dynamite, 30 feet below the centre, bent the bottom plates sharply over one of the frames, the maximum indentation being 4 inches, and broke the frame in two; thus making a leak which sunk the target. This latter has been raised and is being repaired.

The Minnesota Valley.—An interesting illustrated essay Vol. I, page 385 *et seq.*, "Concerning Important Physical Features Exhibited in the Valley of the Minnesota River, and upon their Significance," goes to show that the Minnesota Valley was formerly the source of a great river, which formerly drained the basin of Lake Winnipeg; is accompanied by maps and profiles showing the ancient basin and water-courses. The argument goes to prove that since the drift period the Gulf of Mexico has extended as high up the valley as Dubuque, Iowa; and that it received the waters of the Missouri system, also those of our great lakes, and of an ancient lake equal in volume to all of the latter, and into which the Saskatchewan and Mississippi flowed.

Movable Dams and Hydraulic Gates.—That portion of the report concerning movable dams and hydraulic gates contains (p. 688 *et seq.*) two well illustrated translations from the *Annales des Ponts et Chaussées;* one of them describing the dam at Port à l'Anglais on the Seine, and the other giving the details of the Girard shutters used on the weir of the Ile Brûlée dam across the Yonne.

SYCKELMOORE'S ILLUSTRATED HAND-BOOK OF PHILADELPHIA. Philadelphia: Printed and Published by William Syckelmoore. 1875. 120 pp. 12mo.

This work contains much descriptive and historical matter pertaining to our city, and is illustrated by many finely executed wood engravings. The reading matter and illustrations are well chosen, and of such decided interest that we regret the poor mechanical execution. While the typography is excellent and the heavy tinted paper of fine surface, a poor muddy ink is employed, and the press-work is careless—the cuts apparently not having been "made ready" at all. We trust that these faults will be remedied in the future editions which the work deserves.

WE ARE pleased to notice that the Department of the Interior has commenced the publication, under the direction of the Smithsonian Institution, of a series of bulletins intended to illustrate the collections in the National Museum. Nos. 1 and 2 have already been issued, the former being a *Check-list of North American Batrachia and Reptilia*, by Professor Edward Cope, and the latter the first of a series of *Contributions to the Natural History of Kerguelen Island*, by Dr. Kidder, naturalist to the Transit of Venus Expedition.

ON THE DYNAMICAL LAW OF HORSE-POWER OF STEAM BOILERS. By John W. Nystrom, C. E. Philadelphia: J. Penington & Son. 1875.

This little pamphlet is intended to clear up the long-mooted subject as to what constitutes a legal horse-power in steam boilers. It goes to show that indicator diagrams are no test of the boiler's steaming power, the evaporative test being the true one (subject to the consideration whether the steam pressure should be taken above vacuum or above atmospheric pressure). "The horse-power given by the indicator-diagrams depends much upon the construction of the engine and the grade of expansion of the steam, with which the boiler-maker has nothing to do. The legitimate horse-power of a steam boiler fired by a given kind or quality of fuel, should, therefore, be that passing from the boiler through the steam-pipe, independent of the power given out by the engine. A condensing engine, working with a high degree of expansion, indicates much more power per water evaporated than does a non-condensing engine working with full steam. The boiler-maker should be careful to have the height of the chimney connected with his boiler clearly specified in the contract; also, the steam-pressure to be used. It has been attempted to hold boiler-makers responsible for the action of physical laws which are not under their control."

Mr. Nystrom gives the following formulæ for determining the horse-power of a boiler:

Where W= cubic feet of feed-water at 32° F. evaporated in the time T seconds, and V the volume of steam compared with that of water at 32° F. (according to Fairbairn & Tate), p= steam pressure in pounds per square inch above atmospheric pressure, H= legitimate horse-power of the steam boiler, and S= the space occupied by the steam, in cubic feet; then S= W (V−1). This space, multiplied by the steam pressure, will be the work done by the steam; and as the steam-volume is expressed in cubic feet, the steam pressure must be expressed per square foot, or 144p. The work K, accomplished by the steam, will then be in foot-pounds. K= W (V−1) 144p. Work is the product of force F, velocity V′, and time T. K= FV′T. Power is force multiplied by velocity; or, P= FV′; and is expressed in effects, each of a force of one pound, moving one foot per second; there being 550 effects per HP, or H= FV′ ÷ 550. We then have K= W (V−1) 144p= FV′T= PT. Work is the product of power and time; and eliminating the time from the work we obtain the power, or P= K ÷ T= W (V−1) 144p ÷ T, of which the horse-power will be H= W (V−1) 144p ÷ 550 T; which reduces down to H= Wp (V−1) ÷ 3.819 T. This is the legal horse-power of a boiler, subject to the consideration whether steam pressure should be taken above vacuum or above that of the atmosphere. The quantity of water which a boiler must evaporate in order to generate a given horse-power, will be W= 3.819 TH ÷ p (V−1). It being customary to assume the quantity of water evaporated *per hour*, as a measure of horse-power of a boiler, we substitute for 3 819 T, 3600×3,819= 13748.4, in which case the legitimate horse-power will be expressed thus: H= Wp (V−1) ÷ 13748.4. The quantity of water evaporated per hour, per horse-power, should be W= 13748.4 H ÷ p (V−1). Logarithm for 13748.4= 4.1382522. The higher steam-pressure used the less water is required to be evaporated per horse-power. The English do not consider this question of steam pressure, which is unjust to boiler-makers, and illegal under the law of dynamics. To reduce the feed-water temperature to 32° F., let t= actual feed-water temperature, t'= temperature of the steam, W= cubic feet of water that would have been evaporated from temperature 32°, w the actual quantity of feed-water of temperature t; then W= w (1082 + .305 t') ÷ (1050 + t + .305 t').

When the steam is superheated, more power will be generated per water evaporated; but we have yet no means of correctly determining the humidity or dryness of the steam, for which reason that element cannot appear in the formula for horse-power of steam boilers.

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THE CALLOWHILL STREET BRIDGE

ACROSS THE SCHUYLKILL RIVER, PHILADELPHIA.

The accompanying engraving gives a perspective view of the Callowhill Street Bridge across the Schuylkill River, Philadelphia, and which has been erected on the site of the historic Wire Bridge, and forms a very handsome and substantial structure. It will be of vast convenience to the section of the city in which it is placed, and is also one of the main approaches to the Centennial Grounds. The main span, of 350 feet, was designed by J. H. Linville, Esq., and the superstructure was erected by the Keystone Bridge Company, of which that gentleman is the President. The bridge consists of one span over Callowhill Street, 80 feet; five arch colonnades on east side, 105 feet; main span over the Schuylkill River, 350 feet; ten arch colonnades on west side, 230 feet; bridge over Thirtieth Street, 90 feet; seven spans of plate girders, 300 feet; span over Pennsylvania Railroad, 140 feet; total, 1295 feet. The upper floor of the bridge is 32 feet above the lower roadway, and is 48 feet in width between balustrades; the roadway is 32 feet, and the sidewalks 8 feet each. The lower floor is 50 feet wide, accommodating a roadway and two side-walks. The upper roadway accommodates travel between Spring Garden Street on the east, and Bridge Street on the west.

We beg to acknowledge our indebtedness to Mr. William Syckelmoore, whose Hand-Book of Philadelphia was noticed in our last, for the use of the engraving.—EDS.

THE REMOVAL OF NIGHT-SOIL.

In primitive days there were no accumulations of fecal matters, rendering removal or neutralization necessary. The generous earth received her own again. Those organic compounds, whose presence in the air caused pollution, disease and death, were absorbed, stored up, and in nature's wonderful laboratory so happily re-arranged in plant-life as to minister again to the comfort or the pleasure of the animal kingdom; but "*tempora mutantur, nos et mutamur in illis.*" Convenience, comfort, delicacy, have waved health into the back-ground. Hygeia holds no court in the temple of Cloaca. The earth is robbed for a time of her just due; while the free air of heaven bears sickness to hovel and palace alike. Insidious typhoid claims his innocent victims, no less relentlessly than the bellowing Minotaur, the soft-cheeked virgins of Crete.

The tender babe languishes; the strong-thewed father is cut off in his prime, while "all the world wonders;" and still in every yard are raised new monuments to filth and folly; and the grave-digger prospers by the well-digger's trade.

No thought of neutralizing and fixing the disgusting, death-dealing gases. Fastidious housekeepers shun the subject, until, if there be no friendly gravel to drain the sweet deposits into neighboring wells, its consideration may not be waived or postponed. And then? The "knight of the pole and bucket"—degraded outcast—is summoned; the wages of his wallowing fixed; his task and time appointed. What then follows "must give us pause." The rumble of "midnight artillery" is heard through the streets. The air is scented with the "night-blooming *serious*." Neighboring windows close hastily. The lover pauses in his vows of devotion, or his impassioned appeal, and hurls mental anathemas against the doer of the deed of darkness. The perfumed belle, giddy from the waltz, strolls through the garden on her partner's arm, and notes the fragrance of the camellia-bud, and then the westward breeze comes, freighted with odors *not* of "Araby, the blest"—and the conversation lulls. Sleepers, awakened, vow vengeance against the "moonlight mechanics." Morning comes, and with it a trail of horror, leading to the friendly farm on the main highway, where the "cleaner" leaves the nuisance to the mercies of the rain, and air, and soil, and the contemplation of the passer-by.

And this is a picture, not overdrawn, of our boasted civilization. True, it is a disgusting one:

"'Tis true, 'tis pity,
And pity 'tis 'tis true."

The task of describing this foul blot on our fair escutcheon, even with a view to its removal, is no pleasant one. The subject is unpleasant, the details disgusting; and if it were possible to keep within the bounds of etiquette and so-called "propriety," and render the description more truthful and forcible, we should do so, with the hope of an early remedy of the abuse. There are operations in surgery which are equally unpleasant, nay disgusting; but which are at times not only advisable, but necessary, and the surgeon dare not shrink from proposing nor performing them; nor does odium attach to him for his sacrifice of personal comfort to the public good. Our object is to call public attention to the nastiness and danger of the prevailing system of accumulating and removing night-soil.

There are three ways now in vogue of disposing of fecal matters. To the most common, or well-system, we have alluded; sufficiently plainly, we trust, to show its demerits. The second mode is the washing away by water, which was designed more as a convenience than as a sanitary substitute, and in the latter light, is generally a dangerous failure. The third is by absorption or neutralization, and will be discussed shortly.

I.—Where the well-system must, from motives of economy, or from other considerations, be adopted, protections against unpleasantness and its accompaniment, disease, should be carefully provided. The well must be so deep as not to allow of surface-contamination, nor to require frequent cleansing. If unwalled properly, care should be taken lest wells or

streams be contaminated by percolation, which takes place through much greater distances than is commonly supposed. By walling with cement or concrete, filling takes place more rapidly, the more dangerous gaseous and liquid products being kept from polluting the soil, but given to the air Sanitary considerations would locate the cesspool far from well, or stream or house; but convenience should place a well under or near the house, and that same motive of convenience dictates that the cess-pool also should be near the house! There is no doubt about it, that constipation and its accompanying headaches and derangements, frequently result from the women of a family unheeding, through false delicacy or from stormy weather, the calls of nature, especially where any distance has to be passed in an exposed location. This can be prevented by having a cesspool close to the house, well-walled and impermeable, with a ventilating shaft or chimney, as the only outlet for the gases; and by employing disinfectants in well, "house," and shaft.

Lime, chloride of lime, carbolic acid, or sulphate of iron (copperas), may be used in the well; or a barrel of charcoal set in the "house"; or the ventilating shaft may communicate directly with the flue of the kitchen chimney, and the gases be consumed and carried off without offence or danger.

The seats should be tightly lidded, and kept covered by an automatic closing-device. A very simple way of effecting this, is by nailing a block to the wall back of each lid, so as to prevent the lid resting back against the wall or remaining up, save when the seat is occupied.

The consuming of gases in the kitchen chimney cannot be too highly recommended.

In the country, where the bucket system must be employed, the house should be set only *partially* over the well, and a lid at side or back, over part of the well-top, allows even the clumsy bucket system to be performed somewhat neatly.

The best way of disposing of the products is to bury them, either pure or mixed with coal ashes, in shallow pits in absorbent soil, not near a stream or well. In a year from the burying there will be a rich compost for the field; the soil around the buried matters having become darker and richer.

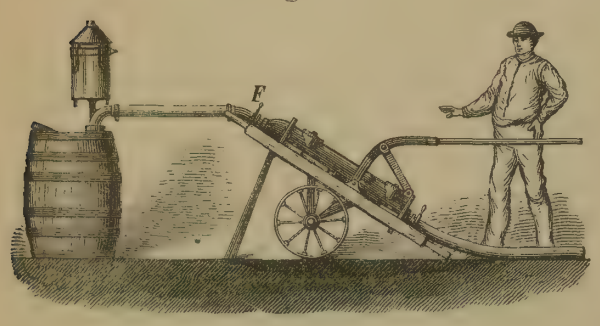
A plan for the country, much preferable to the pit system, is to have a tight tank on wheels to receive the deposits, and to cover and haul this off, and bury the fecal matters without needlessly disturbing them. But in cities or towns none of the above plans should be either recommended or allowed. "Partial relief has been sought in regulations forbidding the opening and cleansing of vaults and cess-pools during the warm months of the year, but the efforts to faithfully execute such regulations have proved futile and abortive, from the fact that in large cities there are many vaults that have not sufficient capacity to last twelve months, and others, though having sufficient depth, yet are sooner filled because of heavy rains, overflows, or the springy character of the contiguous earth. Moreover, the cold and icy seasons are unfriendly to the removal of night-soil by either land or water to considerable distances, from the closing up of the navigable streams, or the bad and almost impassable character of the roads, and besides, in all efforts to utilize this valuable manure for agricultural purposes, much greater difficulties are experienced in the winter than in the summer season; for in the effort to cleanse all the privy-vaults possible of a large city in the cold months, this immense amount of refuse matter is thrown upon the roads or rivers, and into the depots or dumping places in the very worst season for both travel and the manufacturing of poudrette and composts."

The only system permissible in cities is that of *odorless excavation.* Fortunately there are several devices for effecting this desired end; and some of these we shall here notice.

All employ flexible hose to effect the removal of the semi-liquid contents from the pit into suitable air-tight receptacles, and without exposure to the air; and all may be operated in daytime without offence.

The "Odorless Excavating and Manufacturing Company" employs a pump, in line with four inch suction and forcing hose. The solid, liquid, and miscellaneous products are raised by atmospheric pressure to the induction port of the pump. In order that semi-fluid and other substances may pass through without clogging the pump-valves, the latter are of very ingenious and effective construction; "being made of soft, elastic, unvulcanized rubber (A), tubular in form, and composed of two flat pieces, placed face to face, and riveted together at their edges, and, in their normal condition, collapsed. The length of each valve is equal to about three diameters when open. One end is distended, and embracing a collar (B) that surrounds the port, is securely fastened thereto by clamps and bolts. Stiffening straps or braces (C) are arranged at the base of the valve, to directly guard the port and prevent it from being forced into the port by external pressure. The valve is, therefore, a collapsible tube, one end being permanently distended to embrace the port through which the material passes. "The passage of material in one direction through the valve is direct and unresisted, while it cannot take place in the opposite direction, by reason of the collapse of the valve by the pressure on its sides. The valve, being of much greater length than diameter, presents an extended bearing or contact surface between its two sides, which closely engage and surround whatever obstruction may be passing through it at the time of its collapse, forming about the obstruction an air-tight joint, as shown in Fig. 4. At the succeeding stroke of the pump the valve is again distended, and the obstruction passes forward without in the least interfering with the action of the pump.

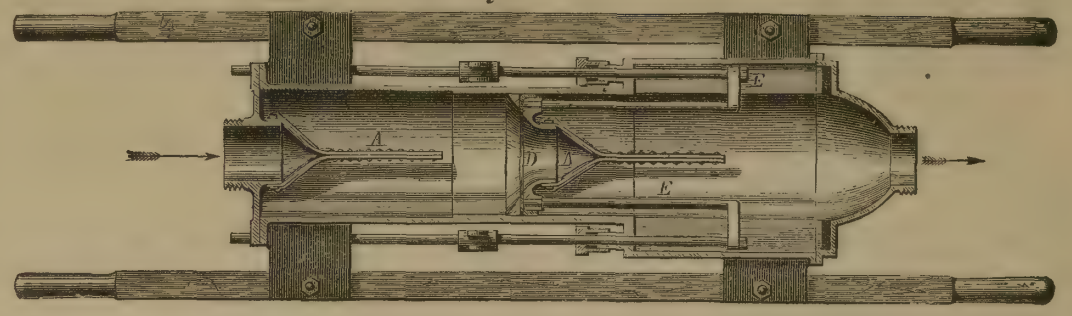
Fig. 1.



The pump is single-acting (Fig. 2), and in form a straight cylinder, provided with one fixed valve (the induction), and one movable, the latter attached to the piston (D) moving in the centre of the cylinder.

Such is the remarkable capacity of this pump for passing obstructions, that sticks, stones, shavings, rags, ropes, bottles, bones or other obstructions, and indeed an entire pair of heavy cloth pants or a full-sized army blanket, may be pumped through with ease. In fact, any obstacle not too large to enter the suction hose, and of whatever length, will pass through the valves without interfering with their action. As an instance, a large rope some forty feet in length has been pumped through with the greatest facility.

Fig. 2



The rods, E, moving the piston, are placed at the sides of the pump, and do not obstruct the opening through it.

For convenience and portability the pump is mounted on wheels placed near one end. When in position for work, it stands at an angle of some twenty-five degrees, and is conveniently operated by the brake or lever. By reason of its inclined position, the air contained in the pump is displaced with facility, and the valves retain their charge. The pump, therefore, seldom requires charging, even when used to raise the material a great distance.

Fig. 3.

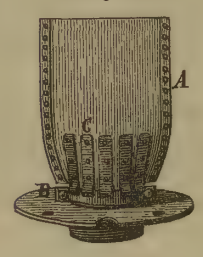
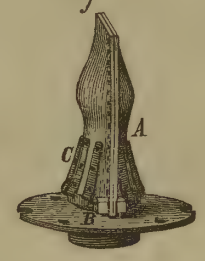


Fig. 4.



The supporting of the pump on wheels also renders the discharging of its contents and cleansing very convenient, by reversing the inclination, in which position it may also be readily charged, when necessary, through the induction port, the discharge being closed.

The couplings (F) used for connecting the sections of hose together and to the pump and tank, are of novel construction, and designed especially for this purpose. Those attached to the pump and tank are provided with fixed wrenches, by which the connection is quickly and perfectly effected. When the hose is disconnected, both portions of the couplings are sealed with suitable caps and the entire apparatus rendered air-tight.

The coupling attached to the induction elbow at the top of tank is provided with a perforated sealing cap containing a sponge which is saturated occasionally with crude carbolic acid, the object being to deodorize the noxious gases arising from the contents of the tank while passing through the streets, and also to relieve the tank from any undue pressure from a like cause.

A flanged collar attached to the top of the tank, supports the charcoal furnace in which the noxious gases displaced from the tank while being filled are deodorized and rendered entirely inoffensive. The purifying action of the fire is immediate and intense, and the displaced gases, after passing it, are entirely without odor—indeed, they are consumed.

After the tank is filled, the deodorizing furnace is removed and a screw cap seals the opening in the tank."

Fig. 6

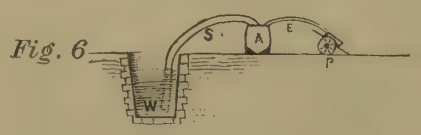
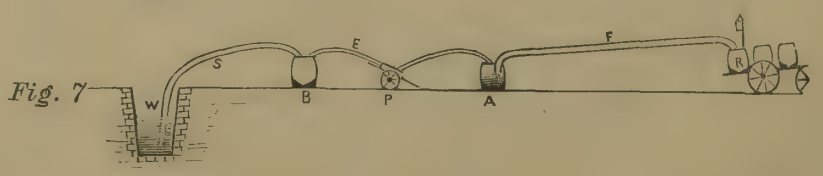


Fig. 7



The "National Odorless Excavating Company" does not pass the material through the pump, and hence the latter requires no explanation, being an ordinary air-pump. One end of the suction-hose (S) is lowered into the well (W), the other being attached to

a tightly closed barrel or tank (A.) The air-suction pipe (E) being attached to this barrel and exhaustion commenced, the material flows from the pit (W) into the barrel (A). When the latter is full, either (1) all hose connections therewith are broken, the openings tightly sealed, and the barrel (A) removed, or (2) a second barrel or tank (R) is connected with the first by means of a hose (F) attached to a pipe passing to the bottom of the first barrel; a third tank (B) is connected with the well (W), and also with air-suction pipe (E); the *air-discharge* pipe (D) being now attached to the first or full barrel (A). The operation of the pump (P) causes the exhaustion of the third barrel (B), and its filling from the well; while the air exhausted from B forces the contents of the first or full barrel into the second receptacle. Thus the material may be forced any distance (after the filling of the first barrel), without passing through the pump.

Referring to "odorless excavation" in general, we quote again:

"Although but a short time has elapsed since its first introduction, so perfect has been the working of the system, and so radical its advantages over the old method, that it has received the endorsement of the most eminent sanitary authorities of the United States, and has already been successfully established in the cities of Boston, Providence, Pawtucket, New York, Brooklyn, Jersey City, Newark, Elizabeth, Philadelphia, Wilmington, (Del.), Baltimore, Washington, Georgetown, Alexandria, Norfolk, Richmond, Charleston, Savannah, New Orleans, Memphis, Chicago, Grand Rapids and Detroit. The remarkable success of the system in so brief a time gives promise of its universal adoption at no distant day." †

[*To be Continued.*]

THE HENDERSON HYDRAULIC CAR-BRAKE.

The accompanying illustrations represent the details and mode of operation of an hydraulic brake for railroad cars, invented by William M. Henderson, and which has of late attracted a considerable share of attention on the part of the technical press of this country and of England. To preface our description, the advocates of the hydraulic system of operating continuous power-brakes —as represented by the Henderson mechanism—claim, "that with equal efficiency of performance, it is at once the simplest in its construction and mode of application of all the brakes now before the railroad world; that it is, furthermore, exceedingly prompt and uniform in action, and reliable, requiring little care and no skilled attention."

The apparatus has been continuously in use on certain American railroads since the month of April, 1874, and, to quote from the statements of several trial-test reports, and the testimony of railway officials familiar with its performance, it has earned the reputation of being efficient, easily managed, not liable to derangement, and inexpensive of operation. The device appears likewise to have demonstrated its reliability during the coldest weather, having, according to trustworthy accounts, successfully passed the ordeal of the winter of 1874-75—a season of exceptionally severe cold—during which, it was, on several occasions, exposed to a temperature of 42° degrees below the freezing point. The liquid employed to operate the brake during the cold season is a mixture of equal parts of glycerine and water.

In the accompanying engravings Fig. 1 represents a locomotive and tender equipped with the braking apparatus; Fig. 2 is a plan of the wheel-base of the tender, showing the arrangement of the pipes and position of the pressure-boxes on the brake beams; Figs. 3 and 4 show the pressure-engine; 5, 6, 7, the pressure-box; 8, 9, 10, the brake-valve; and 11 and 12 the hydraulic coupling used on the flexible portion of the conducting-pipes between the cars.

A, Figs. 3 and 4 of the details, is the pressure-engine enlarged. This is made up of two differential cylinders bolted together, leaving space between for stuffing-boxes. The larger one is an ordinary steam cylinder (12″ diameter, being large enough for the heaviest trains), fitted with a piston; the rod passing through the stuffing-boxes, enters the lesser cylinder, the piston of which is fitted with hydraulic cup-packing. This cylinder is, in effect, an hydraulic press on a small scale (being but 10″ diameter and 12″ stroke in maximum size), operated by the direct pressure of the steam from the boiler, by the manipulation of the brake-valve, shown in Figs. 8, 9, 10. This valve in under the control of the engine-driver. It is a circular slide valve of the common short D pattern. One movement of the lever permits the steam to pass to the front of the steam piston, while the other end is open to the exhaust, and *vice versa*. By reason of the differential areas of the two cylinders, the power of the steam is accumulated upon the hydraulic cylinder, a steam pressure of 120 pounds, producing an hydraulic pressure of 180 pounds upon the pressure-boxes attached to the brake-beams.

The press is fed from a small iron tank (16″ diameter, 13″ high), located on the tender, through a 1″ pipe having a check-valve. Should too great a charge be taken, this will be at once corrected by the press-piston on its return stroke, uncovering an opening—in the side of the cylinder—which communicates by a small return-pipe with the upper portion of the fluid-tank. In the same manner, any possible leak past the hydraulic packings will be returned to the source of supply. A three-way cock is also introduced on the branch leading to the second longitudinal pipe under the tender—the third outlet of the cock leading to the top of the fluid-tank. By turning this cock, and establishing such a communication, the engine-driver can blow around the whole line of pipe (the last pair of couplings on the train being joined together), and discharge all accumulation of air into the tank before starting. In Fig. 1 the pressure-engine is shown under the forward part of the shell of the boiler. This position is not essential, and it may be placed vertically on the fire-box, or in some cases under the tender.

The pressure-boxes are shown in detail by Figs. 5, 6, 7, and constitute hydraulic rams, presenting a surface, to be acted upon by pressure, of about 50 square inches. The special feature is the introduction of a dish-shaped flexible diaphragm of india-rubber, intervening between the face of the ram and the acting liquid; this is securely bolted at its periphery, between the flanges of the pressure-box casting and another, which forms a guide for the end of the ram. This arrangement is designed to obviate all danger from leakage, and to overcome the difficulties experienced in the use of a stuffing-box. The castings are simply bolted together with the diaphragm, as the former come from the foundry without any machine work. This is usually the most vulnerable part of a brake, and in this instance the inventor claims there is nothing to keep in order; it does not even require any lubrication, and cannot be affected by dust; while the usual appliances of pistons, piston-packing, stuffing-boxes, recoil-springs, levers and joints, chains, etc., are dispensed with, together with all the attendant lost motion.

The head of the ram is connected by two ¾″ bolts with the opposite brake-beam, and

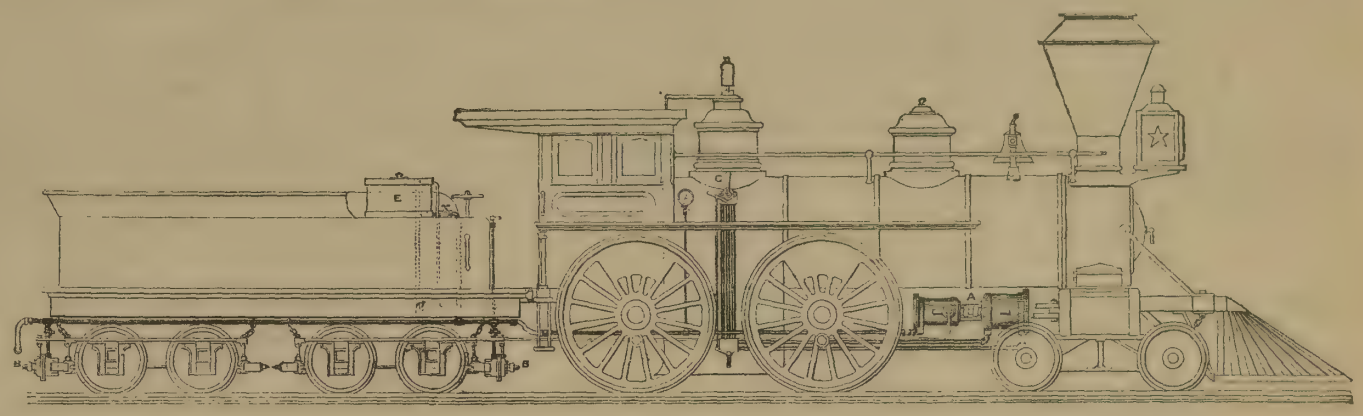


Fig. 1.

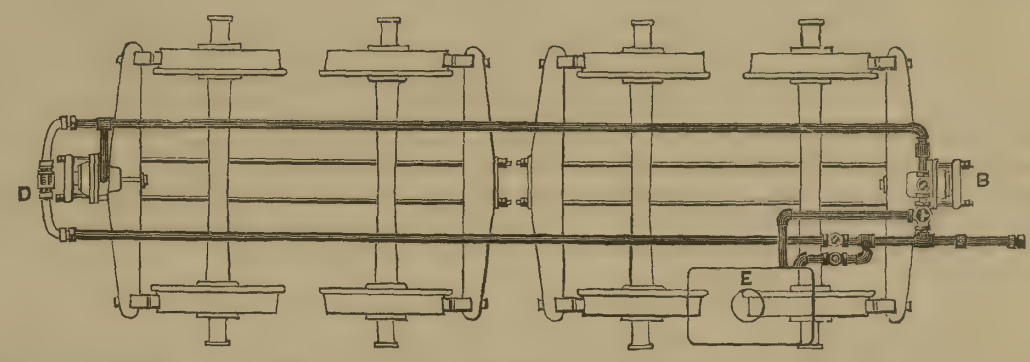


Fig. 2.

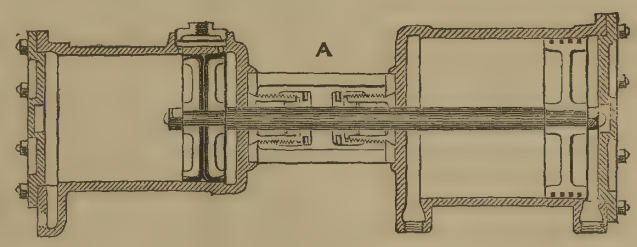


Fig. 3.

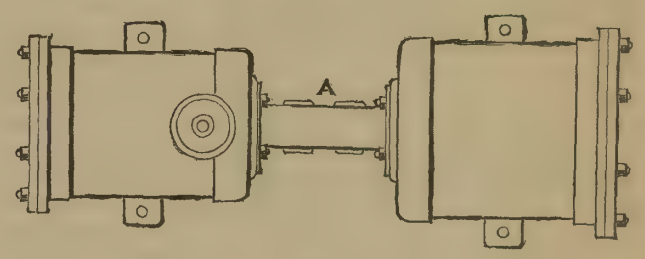


Fig. 4.

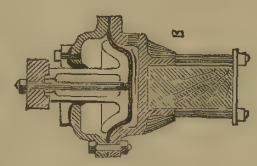


Fig. 5.

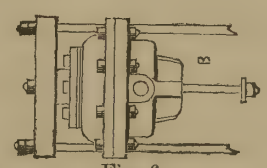


Fig. 6.

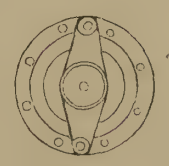


Fig. 7.

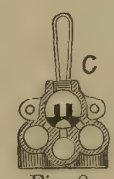


Fig. 8.

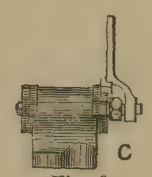


Fig. 9.

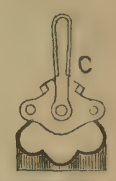


Fig. 10.

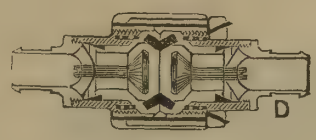


Fig. 11.

A—Pressure-Engine.
B—Pressure-Box.
C—Brake-Valve.
D—Hose-Coupling.
E—Fluid-Tank.

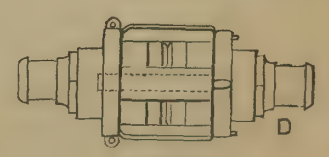


Fig. 12.

HENDERSON HYDRAULIC CAR-BRAKE.

when pressure is applied, one beam becomes the fulcrum for the other, and both are applied with the same intensity—the movement of the rams being only about ¾ of an inch. By reversing the steam in the pressure-engine, a vacuum is produced within the pressure-boxes, and the rams are forced back by the pressure of the atmosphere, the brakes being relieved almost as instantly as applied.

It will be seen by reference to Fig. 2 that double pipes are used under the tender. The same are extended under the cars, and flexible hose is used between, coupled together with the device shown by Figs. 11 and 12. This ingenious form of waste-preventing coupling has a very delicate duty to perform during the time of connecting and disconnecting the cars, especially during cold weather, when glycerine is used with the water.

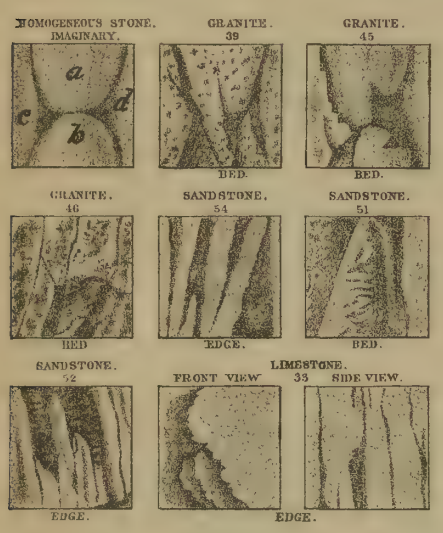
It will be seen that there is a movable seat abutting against a stationary plug; the seat of each half coupling has inserted an elastic rubber ring of diamond section, and is fitted with a coil-spring behind, in such a way as to always keep the aperture closed, except when the coupling is engaged. It will also be observed that before any opening can occur, the facial joint of a pair of similar half-couplings must be sealed, and no leakage can occur in either coupling or uncoupling. The ring on the end of the spring has a chain attached, which is fastened at the other or upper end, to the extremity of the iron pipe where the hose takes hold, and being made half an inch shorter than the hose, it will pull the rings off the ends of the springs, and release their hold upon the coupling in the event of any of the cars breaking loose. The couplings close in the act of parting, without any loss of the liquid.

REPORT ON THE COMPRESSIVE STRENGTH, SPECIFIC GRAVITY, AND RATIO OF ABSORPTION OF THE BUILDING-STONES OF THE UNITED STATES IN MOST GENERAL USE.

BY LIEUT.-COL. Q. A. GILLMORE, CORPS OF ENGINEERS.

[*Abstracts and Abridgement.*]

Cubes, two inches in diameter, were placed between cushion-blocks of soft pine, 2×2×¼ inch, to equalize the pressure. (Hodgkinson showed that trial specimens of iron and wood should be at least 1½ times as high as the width of bed; but stone, except as columns, is usually laid of less height than bed, and the cubical form affords security for the angular breakage necessary to a true result). The cubes were true, smooth and regular, but not polished—except the marbles and granites. They were examined, squared, measured and calipered, and then tested on bed or edge, under steel, wood, lead or leather, as the routine prescribed. They were centred in the press, and the power applied steadily.



Homogeneous stones would seem to break in portions as shown (Fig. 1), fragments *a* and *b* being approximately conical or pyramidal, according as the stone is friable or granular (as sandstone and a few kinds of marble and granite), or compact (as true limestone and most marbles and granites). The more or less disk-shaped pieces, *c d*, are detached from the side of the cube with a sort of explosion, flying off in a more or less intact condition. This form of breakage occurs also in non-homogeneous stones broken on bed; but these frequently have the cone or pyramid longer, if on bed, and split in rectangular disks, if on edge. The forms of fracture of various stones, showing the divergence from the theoretical fracture of the "homogeneous" stone, is shown in the cuts.

In obtaining the specific gravity of stones, some doubt was felt in regard to the best means of obtaining the correct displacement of porous stones; and all stones are more or less porous. By weighing the stone in air and then in water, an error would be committed by saturation. To varnish the stones would not give accurate results; to soak them in very fluid resin could not be practised, because it was desired to submit these stones afterwards to the freezing and other tests. Finally, the plan was adopted of removing all loose particles and rounding off all sharp corners and edges, thus producing the effect known as "water-worn." It was then weighed in air, immersed in water until bubbling ceased, and weighed. It was then taken out of the water, and weighed in its saturated condition. The specific gravity was found by dividing the weight of the dry stone by its weight in air after being saturated, *less* its weight in water; the formula being, specific gravity $=\frac{W}{W''-W'}$; where W equals the weight dry, W″=weight in air, when saturated, and W′ the weight in water.

A number of special experiments were made, showing (1) differences resulting from the use of various surfaces of pressure, including steel, wood, lead and leather; (2) differences in the compressive strength, per square inch, in different sized cubes; and (3) of prisms of various heights in relation to breadth of bed.

(1) The phenomena of breakage by the steel and wood were nearly the same; a tendency, with steel, to make one pyramid of from 50° to 60° angle of base rather than two of 45° each, was occasionally suggested, but not sufficiently so to indicate a law. In both cases the form seemed to be of pyramids forcing out end-pieces, and usually breaking them up. The end-pieces from the wood were, as far as observed, slightly more prismoidal; and from the steel, more wedge-shaped.

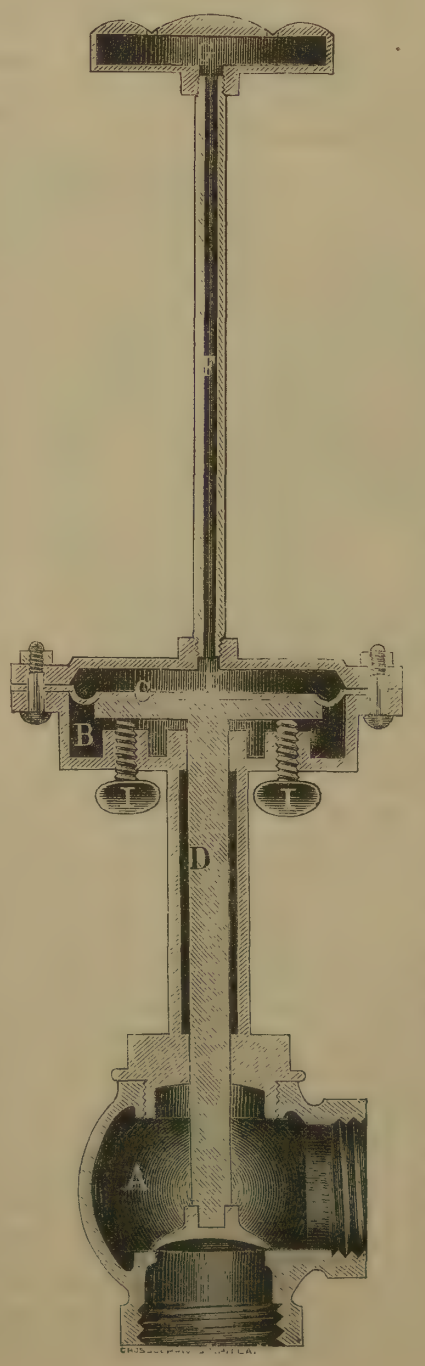
With the lead, and subsequently with the leather, surfaces of pressure, the phenomena were entirely different. A dull thud, instead of a pistol-like report, and sometimes only the recoil of the gauge-needle, recorded the destruction—which was complete. Vertical cracks burst instantly upon the sides of the specimen, about ½ inch apart, and all its cohesion was gone at once. The fragments were prismatic, the greater dimensions parallel with the direction of pressure, and with an unusual quantity of stone-dust intermixed, while the central portions tended slightly towards the pyramidal form. Those in the lead and leather trials seemed riven to their utmost recesses, and crumbled like wood-ashes, when pressed; but those from the steel and the wood trials were solid and apparently uninjured internally. It is not that the lead or the leather spread much; they do not spread in all directions as much as the wood does in one. While one side of the lead or leather is being made smooth by the steel plates, the other appears to be driven into the microscopic interstices of the rock, intruding by flowage, then opening and splitting it by crowding pressures; and thus from each end driving myriads of minute wedges into the rock, while the normal pressure causes a powerful tendency to open in the middle. Lace leather, being extremely close-textured, retains to a great degree, like lead, the characteristic lines of the rock surface stamped upon it.

Table III shows very plainly the quantitative relations which pressing surfaces of steel, wood, lead and leather bear to each other in the breakage of Mill Point granite, East Chester marble and Berean sandstone. These last all being relatively high in their respective resistances, and it being plain that any very weak stone, crushing below the pressure at which wood, lead or leather could exert idiosyncrasies different from those of steel, would yield indifferently to either, it was naturally supposed that the observed differences would rather converge as the compressive resistance of the rocks decreased. But the fact that the characteristic breakage and the observed phenomena of yielding, under wood, were different from those observed under leather or lead, while all concurred in departing more or less from the quantitative results obtained with steel, suggested a continuation of the experiments, so as to include rocks the same in name but different in characteristics.

AVERAGES FROM TABLE III.

KIND OF STONE.	STEEL.	WOOD.	LEAD.	LEATHER.
GRANITE (Millstone Point, Conn.)	92,750	91,500	62,925	
Percentage	100	98.6	67.8	
MARBLE (E. CHESTER, N. Y.)	76,500	70,156	46,250	
Percentage	100	91.7	62.4	
SANDSTONE (Bluish Gray, Berea, Ohio)	45,024	41,160	29,512	26,928
Percentage	100	91.4	65.5	59.8
GRANITE (Keene, N. H.; used inside new Capitol, Albany, N. Y.)	96,000	79,333	57,900	62,900
Percentage	100	82.6	60.3	65.5
VERMONT MARBLE	53,125	43,400	36,802	32,750
Percentage	100	82.	69.4	61.6
General average	100	89.2	65.1	62.3

[*To be Continued.*]



WALKER'S "NON-TAMPERABLE" SAFETY VALVE.

The annexed cut shows a section of Walker's "Non-Tamperable" Mercurial Safety Valve; which is designed with a view to extreme accuracy and sensitiveness, as well as to prevent loading beyond the maximum pressure desired. The valve-chamber (A) has an annular seat upon which rests the valve, an accurately ground disk, from which rises a stem (D) terminated in a disk (B). Upon this upper disk rests a flexible rubber diaphragm (C), whose area is a multiple of that of the valve, and which forms the bottom of a short cylinder (E) communicating with a vertical tube (F) enlarged at the top by a receiver (G) screwed thereto. Through this receiver mercury is poured into the tube (F) and its lower expansion, until F is filled, when no more mercury can be added. The height of the column (F) and the area of the diaphragm (C), determine the static pressure of the invariable mercurial column, and, in conjunction with the invariable relation in area between the diaphragm and the valve, fix definitely the pressure at which the valve will lift. Should it be desired to load the valve to any greater pressure than that corresponding to the length of the tube and the height of its contained mercurial column, there is no feasible means of tampering with it, for there is a perforated sleeve and overflow pipe (not shown in cut) covering pipe F, and should more than the proper quantity of mercury be added, it will overflow and pass out through the perforations above referred to. To blow off at any lower pressure than that to which the valve is set, thumb-screws (I I) will lift the disk, stem and valve in an instant. It is claimed that the valve is extremely accurate and sensitive, commencing to blow off at the given pressure, at two pounds above, blowing off freely, and closing again at a half pound below.

For further particulars address J. M. Richmond, Haddonfield, N. J.

The Polytechnic Review.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH. D.,
ROBERT GRIMSHAW, PH. D., } EDITORS AND PROPRIETORS.

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PHOTO-ENGRAVING.

The invention of methods by which the photographic image may be multiplied with rapidity and economy, and the application of photography to the improvement, simplification and cheapening of the several processes of engraving, comprise a field of investigation, which has, of late, been assiduously and successfully cultivated. The mere enumeration of a few of the more prominent inventions—the photo-lithograph, the photo-engraving, the Albertype, the Heliotype, the Woodburytype—will suffice to indicate to the intelligent reader the decided progress that has already been achieved in this direction, and—if inventive activity be a safe guide in forming a judgment—the importance that attaches to it.

Of the numerous applications of photography as an adjunct to the engraver's art, with which we are specially concerned, the public is perhaps most familiar with the process known as photo-lithography, one of the earliest inventions in this field, and one that has been largely introduced the world over. Without entering into lengthy details, which are unnecessary for our present purpose, it will suffice to state that, with its aid, it is possible by very simple means to transfer to the lithographic stone a photographic image of the drawing to be engraved, or of the engraving to be copied, from which any number of prints that may be desired may be obtained by the usual process of lithographic printing. From what has preceded, it will be obvious that any original in lines or dots, such as copies of wood-cuts, lithographic or copper-plate engravings, or pen-and-ink drawings, can be reproduced with photographic fidelity, and, within certain limits, of any desired size. The peculiar merit of the photo-lithographic process resides in its economy, inasmuch as the task of the draughtsman, who, in the ordinary lithographic process, must accurately and laboriously draw in reverse upon the stone the subject to be produced, is here unnecessary. The camera takes the place of the artist's pencil, and effects instantaneously and with incomparable fidelity the most laborious and generally the most costly portion of the work. By pressing photography into his service, therefore, the lithographer has effected not only a decided improvement in illustrative art, but, likewise, a decided cheapening of his work. This last consideration is of prime importance, and, next to the quality of the work, must be the distinguishing feature of any innovation designed to extend the utility of the engraver's art.

If the business of our publishers has of late vastly extended, the public desire for the abundant illustration of their productions has fully kept pace with it. The differentiation of old, and the birth of new industries, going on almost beneath our eyes, in these active, progressive times, and the continuously growing pressure of competition in numberless trades and occupations, have likewise given an impetus to illustrative art scarcely less decided, for proof of which let the multitudinous forms of advertising, by means of cards, pamphlets, catalogues, *et id omne genus*, now-a-days so commonplace, bear testimony.

Despite its great merits, however, the art of photo-lithography only partially realizes the demands of the times. Its great drawback consists in the necessity of employing the lithographic process of printing, which it cannot avoid. This is attended with considerable expense as compared with typographical presswork, and in consequence it happens in many cases, that, despite its relative costliness of production, it is cheaper to have recourse to the wood engraving. On the other hand, the art of wood engraving, although now brought to a high state of perfection by the introduction of many labor-saving devices, is yet far too expensive for general employment; so that, although each of these arts possesses advantages *sui generis*, neither realizes altogether the conditions of public necessity.

If it were possible to *combine* the economy and celerity of photo-lithography (attained by permitting the camera to do the artist's work) with the advantage which the wood-engraver enjoys in employing the typographical press to print impressions of his work then, indeed, would a great desideratum be realized.

This desirable combination has lately been effected in the several processes to which the generic name of *photo-engraving* has been attached. Briefly described, photo-engraviug consists in the photo-chemical or photo-mechanical production of metal-plates, on which the subject is produced *in relief*, from which, therefore, any desired number of impressions may be printed on the typographical press. The introduction of these very desirable improvements, though of quite recent date, had already given a decided impetus to illustrative art. The advantages afforded by them are most manifest in the reproduction of wood engravings for book and newspaper illustration. By their aid a stereotype, electrotype, or zinc plate of the subject is produced in relief, and as the camera is called into requisition, thus obviating the necessity for the copying artist's handiwork, the peculiarly practical merits of photo-engraving will readily be comprehended; and it is not affirming too much to say in reference thereto, that when the public shall have become more familiar with the advantages afforded by the new art, on the score of fidelity and rapidity of execution and notable cheapness, the employment of photo-relief engravings in all quarters will vastly extend. We already observe the influence which they are exerting in the decided increase in the number of illustrated newspapers, and in the more profuse illustration of others, as well as in the productions of our publishers.

In view of the foregoing comments, a brief historical *resumé* may not be uninteresting. So long ago as the year 1813, twenty-five years before the art known as photography was invented, Niepce made the attempt to produce metal plates, engraved by the action of light, for use in printing. Following in the footsteps of this pioneer, numerous inventors have since invaded the field with varying success. It is only, however, within the last few years that the art of photo-engraving has been brought to a condition of practical utility, and with its development in this country, the name of Mr. John C. Moss, the Superintendent of the Photo-Engraving Company of New York City, is so intimately associated, that it is no exaggeration to state that whatever of popularity and success the art has achieved with us, has been practically his creation. We have read with great interest the history of this inventor's struggles with difficulties, disappointments and defeats, and his final emergence from "a sea of troubles" in the formation of the photo-engraving company in April, 1872. On the outset of his experiments, Mr. Moss had fondly cherished the notion that no sooner should he demonstrate his ability to produce satisfactory work, than a competing audience of publishers and capitalists would be at hand to participate in the fruits of his ingenuity and skill; but like many inventions of great merit, it proved that this likewise was slow in winning its way to public favor. Publishers had heard of processes before, and many of them, by reason of unsatisfactory trials and loss of money invested in promising experiments, were prepared to turn the cold shoulder to any thing having the name of "process." Artists, too, looked askance at the innovation. It promised, to be sure, to reproduce their own drawings with a fidelity which the wood engraver could not hope to equal; but it required of them more care in the preparation of their drawings, with pen and ink, than they had been accustomed to bestow upon their work. Heretofore they were enabled to avail themselves of the kindly pencil and brush to fill out details, leaving the work to be filled in according to the taste and method of the wood cutter; now they were required to furnish drawings, executed with great care and attention to the details they had previously ignored.

In conquering these and other difficulties, too numerous to mention, the new organization may be truly said to have created a new industry; the successful establishment of which involved the introduction of expensive and special machinery, the training of workmen to perform new operations, the education of a corps of skilled draughtsmen into new habits and methods, and finally, the winning of popular favor—more difficult than all.

The company occupies four stories of a building on Courtlandt street, New York, and employs between fifty and sixty hands, turning out an amount of work, that would, we are credibly informed, require one thousand skilled wood engravers. It has produced up to the present time over seventy-five thousand plates, which have found their way into every State and Territory of the Union.

It is not the purpose of this historical sketch to enter into the technical details of this and other processes of photo-engraving, though that subject may afford material for a subsequent article. Suffice it to say that while some of the most important operations are kept secret, the process of the photo-engraving company is distinguished from most other methods in use for the purpose, in dispensing with "etching," or the biting of the lines by acids. The process is, therefore, as we have previously remarked, photo-mechanical, and not photo-chemical.

The course of a plate is, in substance, as follows: From the subject, properly prepared, an ordinary photographic negative is made, the requisite being that this should be perfect in every detail. This negative is sent to what is called the secret department, from which it emerges as a plaster mould, which is then stereotyped in the usual manner. The rough plate is then routed, its imperfections touched up, squared and mounted type-high on a block, and is then ready for the press. These operations continue but a few hours, during which time a plate may be produced which might have occupied a skilled engraver as many days.

Among the labor-saving devices of Mr. Moss, that employed for the preparation of pen-and-ink drawings from photographs or other subjects requiring to be re-drawn is quite interesting. From the copy, a plain photographic positive is made on arrowroot paper, and double the size of the desired plate. This print is "fixed," and well washed, but not "toned." The drawing is made directly upon this print with pen and india ink. The outlines and important parts being completed, the photographic color is bleached away, by flowing over the surface an alcoholic solution of bi-chloride of mercury (corrosive sublimate). The finishing touches are then added, when the picture is ready for the camera. By this ingenious device, the tedious operations of tracing and sketching are obviated, and a high degree of accuracy is attained. For a large class of work, such as catalogue illustrations, buildings, machinery, &c., this method is found to be highly advantageous. It will be manifest, however, that for a large share of the work to be executed by photo-engraving, no drawings are required, as it will consist in the direct reproduction or copying of wood-cut, lithographic, and other prints, either reduced, enlarged, or of the same size as the originals.

Finally, we may add that while we are disposed to award the tribute of praise to the deserved success of the Photo-engraving Company, we anticipate in the near future, developments in the same field of investigation, quite as interesting and no less important than the innovations that have already been made. *

A NOVEL DRAW-BRIDGE.

A recently patented draw-bridge, designed to afford perfect facilities for crossing navigable streams without impeding navigation, is the invention of Lt.-Com. H. H. Gorringe, U. S. N., of Washington. The bridge is composed of a number of floats, each pivoted or hinged at one end; the other end being moored to anchor-piles by means of a chain passing over a windlass on the swinging end of the draw or leaf. By revolving the windlass the draw or leaf may be swung clear, so as to afford vessels a single passage as wide as the length of the draw; a reverse motion of the windlass closing the draw and opening the roadway. Since this operation may be performed with either or all of the floats, vessels may pass through the bridge at any point selected, or the whole width of the river may be thrown open to navigation. The inventor, among other things, claims "cheapness and facility of construction, greater security than ordinary bridges, freedom from obstruction to navigation, and from risk of damage by freshets, moving ice, and other floating bodies."

FIRE PROTECTION.

The illustrated articles on Modern Fire Engines, now appearing in THE POLYTECHNIC REVIEW, form part of an extended series bearing upon Fire Protection, and embracing both Fire Proof Construction and Fire-Subduing Appliances of every description. The editors request inventors, manufacturers and others having any data relating to the subjects named, to forward them promptly to this office, that the articles may be rendered as nearly complete as possible.

MODERN FIRE ENGINES.

[CONTINUED]

Of those machines having boilers with both water-tubes and smoke-flues, may be mentioned the "Silsby," built by the Silsby Manufacturing Co., Seneca Falls, N. Y., and the "Clapp & Jones," built at Hudson, N. Y.

The Silsby boiler is here shown in vertical and horizontal sections. The fire-place is shown at M, figure 4, with vertical water-tubes *i i i* passing directly through the fire. These pipes are closed at the bottom, and open at the top, where they pass through a water-tight plate, *g*, and communicate with the water in the boiler, which rises to the level of *f*. They are represented in the sections at the sides, *k k* being the external, and *l l* the internal tubes, both open at the top, and the internal tubes having openings at the bottom. This arrangement causes a constant current, the water rising on the outside of the tube *l*, as it is heated, and its place being supplied by a current flowing downward through the tube from the boiler. The smoke and flame pass between the tubes *i i i*, and up through the flues *h h h*, which are represented in section at the sides *j j*. The vertical tube boiler is one of the best in use. The celebrated Merryweather (English) engine employs a similar principle.

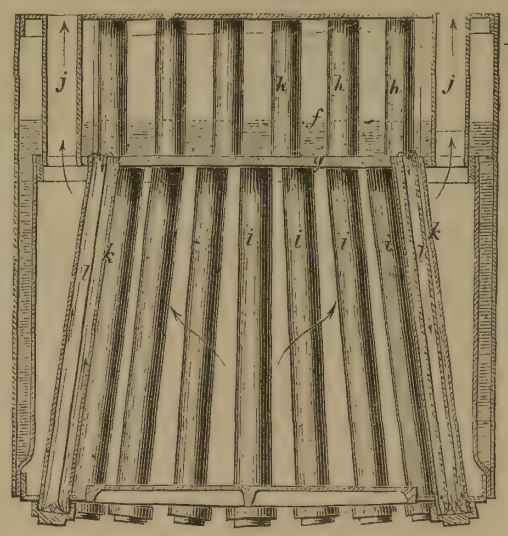


Fig. 4

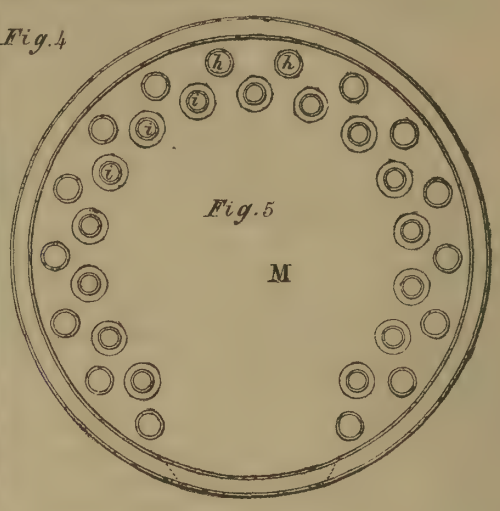


Fig. 5

The Silsby "second-class" boiler has an external diameter of 38 inches, and an extreme length of 58 inches; the height from base of crown-sheet being 33 inches. The average length of the suspended water-tubes, *i i i*, having concentric circulation tubes therein, is 26 inches; there being 68, 1½ inches in internal diameter, and 93 of 1¼ inches; their material being wrought iron. There are 39 two-inch smoke-flues, *h h h*, each 21¾ inches long; and 51 of 1¼ inch diameter, also 21¾ inches in length. The total heating surface is 200 square feet; the grate surface being 4½ square feet. The feed may be hot or cold, as desired. The "variable exhaust" used in regulating the draft, has four 1⅛ inch nozzles, controlled by a lever.

Since writing the above, the Silsby boiler has been modified by greatly shortening the smoke-flues so as to completely submerge them and the upper sheet. The change is to be commended.

kins, the inventor of the steam-gun, and is now employed, with modifications, in the Field boiler in England, and the Wiegand in America. The light triangular diaphragms in the Clapp & Jones tubes are perhaps an improvement.

Of "smoke-flue" boilers, having natural or unaided circulation, there is a large number. The engine built by the Amoskeag Manufacturing Co., of Manchester, N. H., being the most widely known of these, the term "Amoskeag type" is commonly applied.

An Amoskeag engine is here shown in longitudinal vertical section. The boiler has a fire-box A, surrounded by water. A great number of small flues, B, passing through the water, connect with a submerged smoke-dome, C, which discharges through the stack D. The feed-pump is shown at G; the feed being cold.

The "second-class" Amoskeag boiler has a fire-box 28⅝ inches internal diameter, and 22 inches in height; the grate surface being 4.55 square feet. There are 265 copper flues, each one inch in diameter, 22 inches long. The conical smoke-box is of unusual size; the steam-room small. The smoke-stack is steam-jacketed for 12 inches of its height.

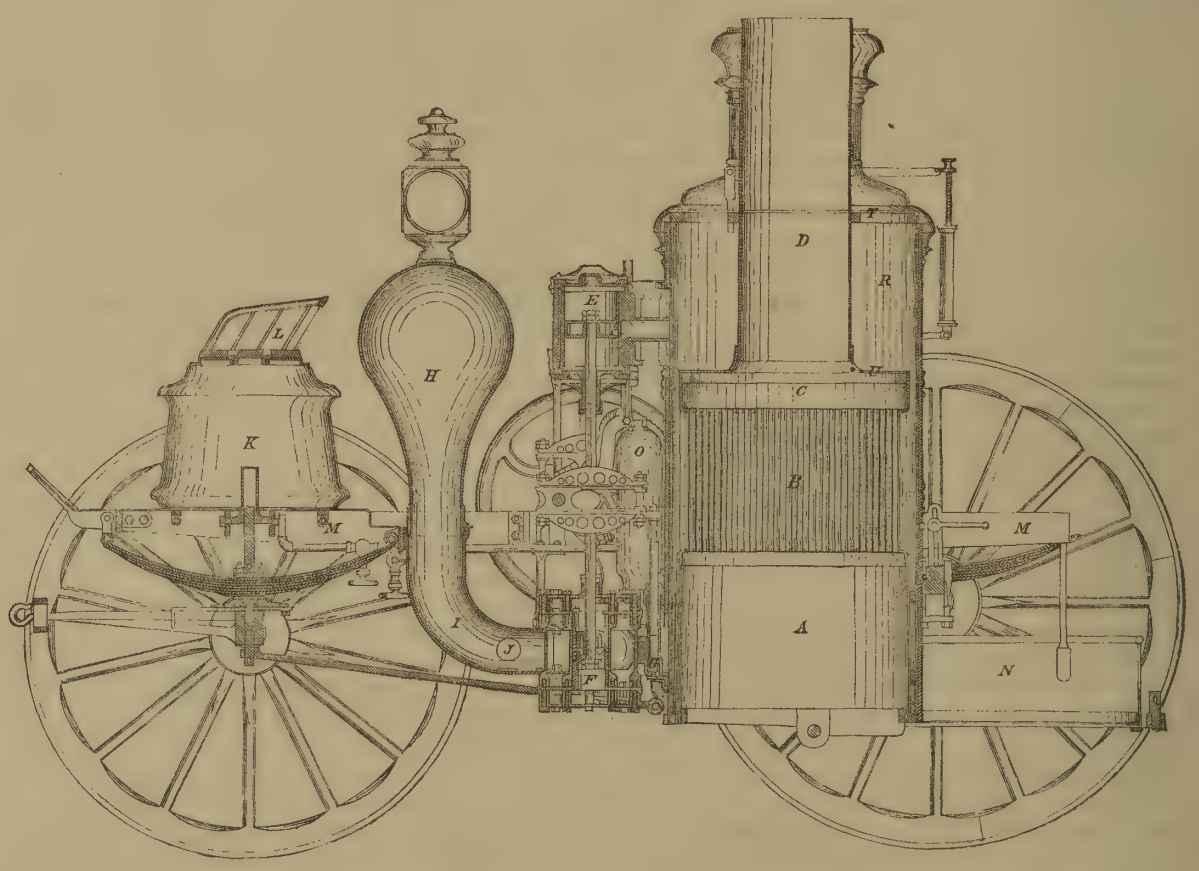


Fig. 10—Section of Straight-Frame Amoskeag Engine.

Fig. 6

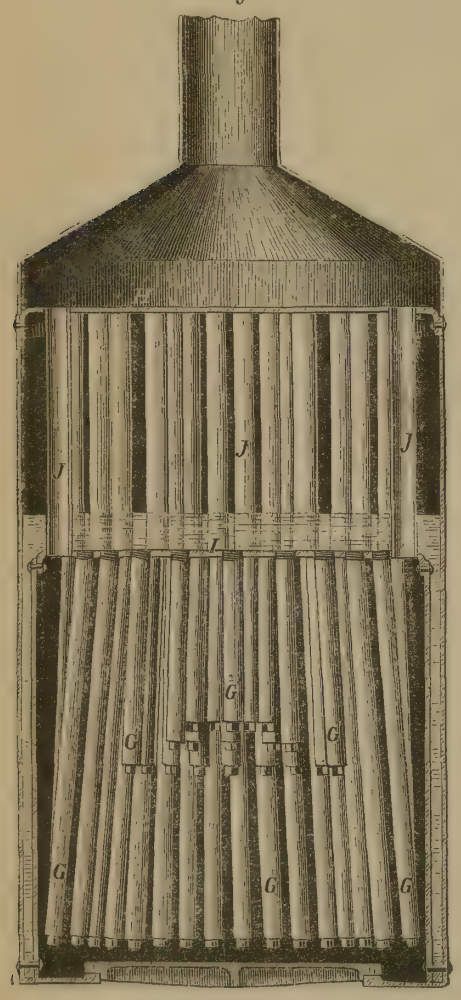
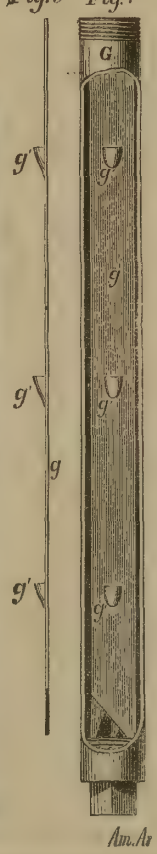


Fig. 8

Fig. 9 Fig. 7



Am. Ar

The Clapp & Jones boiler greatly resembles that used by the Silsby Manufacturing Co. A vertical section is shown herewith. It has both fire and water tubes; the fire tubes, J, extending from the crown-sheet of the fire box up through the "shell" and the water-tube G G G, being pendent from the crown of the fire-box. The outer rows, G G, of water-tubes extend nearly to the bottom of the fire-box, and surround rows of shorter tubes, G G, and G G, which are about half the length of the outer row. One of these water-tubes, detached from its position, is shown in Fig. 7, broken away to exhibit the arrangement provided for the circulation of the water. Fig. 8 is a transverse section of the tube, showing the diaphragms (which correspond with the inner tube in the Silsby boiler, and one of which is seen detached in Fig. 9), which are arranged so as to form a triangle when inserted in the tubes. In this way the water is isolated into thin films or sheets, so that the generation of steam will be very rapid—the diaphragm serving to establish return passages for the water to supply the place of that converted into steam and carried up by steam. By the arrangement of openings *g g*, much of the water mechanically raised will be allowed to return without passing all the way to the top of the tube. A "variable exhaust" nozzle of conical arrangement is very quickly operated by the engineer so as to increase or lessen the draft at any time.

The "second-class" Clapp boiler has 3½ square feet of grate surface, and 205 square feet of heating surface.

The "drop-tube," with concentric circulator, was originally designed by Jacob Perkins, the inventor of the steam-gun, and is now employed, with modifications, in the Field boiler in England, and the Wiegand in America. The light triangular diaphragms in the Clapp & Jones tubes are perhaps an improvement.

Of "smoke-flue" boilers, having natural or unaided circulation, there is a large number. The engine built by the Amoskeag Manufacturing Co., of Manchester, N. H., being the most widely known of these, the term "Amoskeag type" is commonly applied.

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The "second-class" Amoskeag boiler has a fire-box 28⅝ inches internal diameter, and 22 inches in height; the grate surface being 4.55 square feet. There are 265 copper flues, each 18 inches long, and 1¼ inches in diameter. The height of the boiler is 64 inches; the outside diameter of the shell being 30½ inches. The smoke-pipe is 13⅜ inches in diameter. The total heating surface is 151 square feet.

The "Dennison" engine, of Newark, N. J., the "Harrell," of Paterson, N. J., and the "Hunneman," of Boston, have boilers of the regular Amoskeag type.

The "Button," of Waterford, N. Y., has a boiler differing from these, only in having an oval sleeve passing transversely through the fire-box, and through this the axle passes.

A Button second-class (or "5000 lb.") engine, located at Peabody, Mass., has 7⅜ square feet of grate surface, and 300 square feet of heating surface. The shell is 62 inches in height, and 39 inches in external diameter. There are 375 copper flues, each 1¼ inches in diameter, and 20 inches in length.

The "Union" Button engine (old style), of Lancaster, Pa., has a cylindrical boiler 56 inches long, with a conical top 12 inches high, is 34½ inches external diameter, the waist being contracted to 26¾ inches. The fire-box is 32 inches in diameter, 16 inches high. There are 196 flues, each one inch in diameter, 22 inches long. The conical smoke-box is of unusual size; the steam-room small. The smoke-stack is steam-jacketed for 12 inches of its height.

The "Gould" engine, now made by B. S. Nichols & Co., Burlington, Vt., has a boiler of the same general type as the Amoskeag, being upright and tubular, with submerged smoke-dome, and relying for its heating surface upon the great number of smoke-flues. There are, however, these important differences: The smoke-box (C) is conical, giving increased strength and better draft; while requiring fewer joints to make and keep tight. The fire-box, B, is tapering, giving increased grate-surface, better arranged heating surface in the fire-box walls, and better circulation in the water-leg. The feed is hot; a "circulator" preserving the coil from burning out when not in use.

The second-class Gould engine has a fire-box 34 inches in internal diameter, 6¼ square feet of grate surface, and 161 square feet of heating surface. The boiler is 60 inches in height, and 33¾ inches in diameter (above the fire-box). There are 349 copper flues, each 1¼ inches by 14 inches. The material of boiler-shell is steel, $\frac{3}{16}$ inch thick; fire-box, cone and smoke-stack being ¼ inch; heads $\frac{5}{16}$ inch; all with Norway iron rivets and stays. †

[*To be Continued.*]

ROADWAYS.

I.

The course of civilization and prosperity has ever been marked by attempt to shorten the distance or time which separates cities and places. In the earlier days, these efforts were principally directed to the construction of smooth and durable roadways of easy gradients; while at a later date, progress and inventive genius have been in the direction of improved vehicles. The demands of modern civilization are for means of rapid transit. Steam answers so readily to these demands, that the making of approximately perfect *rail*-roads apparently distracts our attention from the construction of good roadways for non-tracking vehicles. We find, then, that the great commercial and manufacturing cities, while connected by well-ballasted and equipped railroads, are traversed by roadways varying in quality from passable down to execrable.

FIG. I.

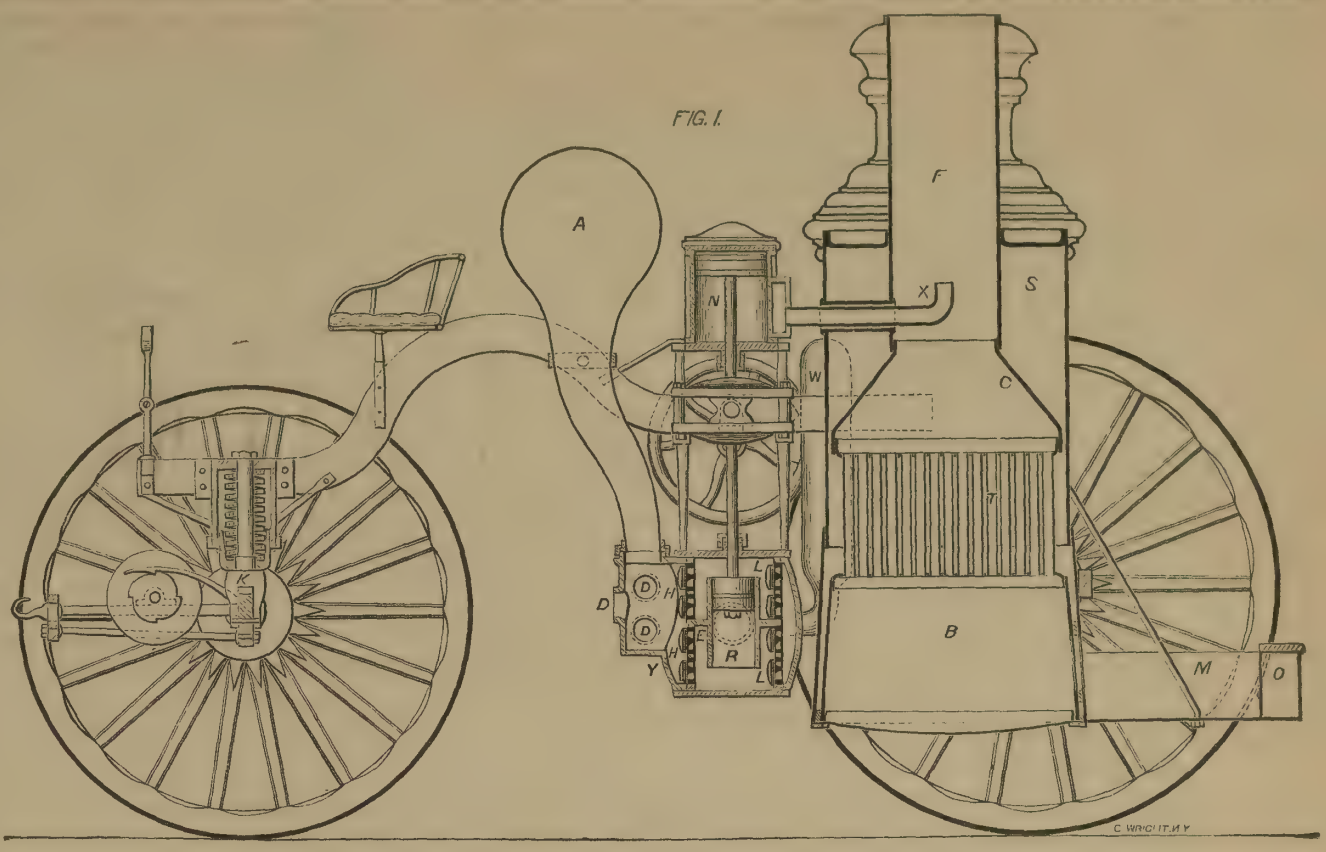


Fig. 11—Section of Gould "Crane-Neck" Engine.

Spasmodic attempts have been made to secure a pavement possessing all the requisites of a good road-surface, the most essential of which are (1) smoothness and hardness, to promote and maintain ease of draught, and lessen the wear and tear of vehicles; (2) security of foothold for animals, and immunity from slipperiness through wear; (3) freedom from noise, dust, mud and noxious vapors; (4) susceptibility of rapid and thorough cleansing; (5) durability and capability of being rapidly taken up in places and relaid, to give access to gas and water-pipes and sewers; (6) susceptibility of laying and repairing cheaply, at all seasons.

There are here, apparently, some requisites difficult of attainment. The model road must be smooth, and yet not slippery; firm, yet elastic; permanent, and yet readily taken up and relaid. Each material used for our roadways has some good qualifications—no one possesses them all. We must, however, bear in mind that these requisites vary in *essentiality*, according to circumstances; that there are situations where ease of traction is the main *desideratum*, others where permanence must be secured at all hazards; and under yet other circumstances, a clean and quiet surface is most desired. Evidently our course is to consider intelligently the various qualities of the road-beds now known, and to construct our roads with a view to meeting most fully the requirements of each particular case.

This much, however, may be set down as a premise: that no road-surface, however excellent in itself, will give permanent satisfaction unless it is underlaid by a road-bed suited to that particular surface. Unless the foundation be good, we cannot expect durability in the superincumbent layer.

The pavements most familiar to us in cities, are (1) the cobble, (2) broken stone, (3) stone blocks, (4) wood, (5) concrete and mastic, (6) rock-asphalt. There are some which are composite in their character, but which we may class according to their chief component.

The foundations usually employed for a road-bed or foundation are (1) hydraulic concrete, six to eight inches thick, (2) rubble-stone on edge, (3) cobbles set in gravel, (4) well compacted small rubble-stones, (5) broken stone. As foundations, these may be rated in the order named, and should be so laid as to present and give to the supposed pavement a slightly convex surface, which facilitates drainage and cleansing.

Considering the qualities of the pavement or road-surface, we find the *cobble* to be hard, but not smooth, and hence far from promoting easy draught; while any one who has watched a carriage bouncing or jumping over a cobble or any stone block pavement, will see that these do not give the minimum wear to vehicles. It affords, when either new or old, an uneasy and insecure foothold for animals. It is somewhat dusty in dry weather, very muddy in wet, noisy at all times. It absorbs noxious liquids, and gives out unwholesome vapors. It may be cleansed neither rapidly nor thoroughly. It may be taken up easily in portions and readily relaid, although the areas thus trifled with are apt to be too high at first, and to sink below the general surface in time. It may be laid and repaired cheaply in almost any season; but this repair is constantly needed. The differing areas and shapes of the cobbles cause them to sink variously into the foundation, and hence the surface, primarily uneven, becomes dangerously so in time. "A cobble pavement laid on Barke St., Pittsburg, in 1872, was repaved in 1874, and again in 1875, costing the city $4.30 per square yard in three years." Altogether, the cobble-stone pavement is utterly abominable, and a disgrace to any city using it.

The *broken stone* pavement is tolerably smooth and hard, gives sufficiently easy draught, is only moderately destructive to vehicles, affords secure foothold, never becomes slippery, is not noisy, but is muddy and dusty, and absorbs noxious liquids, giving out foul vapors. When well rolled it may be cleansed readily by sweeping or washing. It is tolerably durable under light traffic, while heavy loads and narrow tires cut it into ruts. It affords easy access to underlying pipes, but, unless well rolled when relaid, cuts readily. It may be laid or repaired at any season. While excellent for park or suburban roads, largely devoted to pleasure-driving, it is totally unfitted for built-up neighborhoods, on account of the intolerable nuisance of mud and fine gritty dust, and will not suit for heavy traffic.

Stone-blocks are used in three shapes: (1) cubical, (2) parallelopipeds, set upright and with square ends, (3) brick-shaped parallelopipeds, set on edge; this last is the best form. The longest edge should be set across the street, and the blocks laid "breaking joint." This mode of laying gives greatest security of foothold and freedom from wheel-ruts. The blocks should have equal areas in order that they may not sink unequally into the foundation. The stone-block pavement gives out a deafening din and rattle from feet and vehicle combined, is hard upon vehicles, is somewhat dusty and muddy, absorbs filth readily, and gives off unwholesome exhalations. On taking up any pavement with frequent interstices, the ground beneath is found to be rich and black, having absorbed and retained large quantities of fertilizing material, independent of that given out to the air. It is more readily cleansed than any other pavement except asphalt. Where *good* stone blocks are used they make the most durable of all pavements; but poor stone is less durable than good asphalt. They are readily taken up and relaid, and may be put down at any season.

Wood-pavement.—There are scarcely any two of these alike in construction, qualities or cost. One variety, largely tested, is made of blocks 3½ inches wide, 10 inches long, 6 inches deep, laid upon a foundation of two thicknesses of planks, well pitched and nailed together. The blocks are laid end to end across the street; but between their sides are ¾ inch joints (the lines being kept by fillets nailed to the planks) filled with clean, small pebbles, rammed in, and then run with a composition of pitch, tar, or other bituminous substances. Another variety of wooden road-surface is made of eight inch cylindrical lengths, sawed from the unsquared timber, and set on end upon a suitable elastic foundation, the interstices being filled and grouted with gravel and tar, or other suitable material. The cost of material and laying is less than for squared, sized and bonded blocks.

Cheapness in first cost being a decided object, the softer woods are generally chosen for pavements. They must be set on end, in order that the fibres may present the greatest resistance to compressive and battering forces. And it is to be regretted that motives of economy preclude the proper preservation from decay of these short porous blocks, exposed to absorptive action at opposite ends of their natural capillary sap-channels, and hence peculiarly liable to rot and disintegration by frost. To this cause, perhaps, as much as to the compressive action of the loads imposed, and the lack of properly elastic foundations, we may ascribe many of the reported failures of wood pavements to stand satisfactorily the durability test.

Some wood pavement, laid as first described, in the Old Bailey, London, 1839, lasted 7 years, being neither preserved nor cleansed. The average life of wood pavement in London, on busy streets, was found to be 9 years; with light traffic, 11¼ years; nearly all of these having the blocks relaid, and in some parts replaced. In New York, the average duration is found to be 5 years only; a result surely not attributable to the extra amount of wear and tear, and perhaps very largely resulting from the employment of softer blocks.

In summing up, then, the qualities of wood pavement, we find it (1) sufficiently smooth and hard to give good draught, quite easy on vehicles; (2) becoming slippery when muddy, though not so much so as asphalt (nor nearly so insecure as stone that polishes), when either wet, muddy or dry. When kept clean, there is little difference in foothold on wood, asphalt, or stone blocks *that do not polish by wear*.

"Under sharp frost, under rain or snow, asphalt and stone are generally quite dry and safe, while wood retains its moisture and is quite slippery. In the condition in which they are usually maintained, a slight rain adds to the slipperiness of each; this state beginning with the rain, but the worst condition of wood ensues later and lasts longer." (3) It is nearly free from noise, giving out only an unlocalized rumble, affording crossing foot-passengers no such warning as they receive from the crash and din of cobbles or stone-blocks, or the hoof-clickings on the asphalt. Theoretically, we should expect wood pavements as heretofore laid to absorb noxious liquids readily, and evolve unwholesome vapors freely, more so than any others laid, and the fact that, practically, no complaint of such pollution has ever been made by residents along a line of wood-blocks, does not refute the theory; for citizens are poor sanitarians, and do not recognize the fact that

while unpleasant exhalations may be unwholesome or noxious, all unwholesome or noxious vapors are not unpleasant or even noticeable.

Wood pavements make but little dust; but both mud and dust, if tracked from other quarters, adhere with more tenacity to wood than to stone or asphalt, especially after the wood fibres begin to crush or abrade, and the grouting to wear; hence (4) we must place the wood pavement as less readily cleaned than asphalt or stone-blocks.

(5) It has never yet been supposed that a wood pavement is as durable as stone or asphalt; but it could be made very much more lasting by having an elastic foundation, and by preserving the blocks from rot and frost, by suitable antiseptics or "fillers." Small repairs may be done as readily as on a granite-block pavement. (6) The "Old Bailey" pavement alluded to, was laid about 125 yards per day. The "grouting" cannot be done in wet weather.

There is one peculiarity concerning the "wear" of wood pavements—that the rough riding it produces annoys no one but the occupants of the vehicles. With the cobble or granite pavement, the crushing and hammering of the tires (while it makes the head swim and ache if one is in a close carriage), reaches all the tympanums in the vicinage.

Concretes and Mastics.—Concerning the merits of the various concretes, whether simple or complex, much could be said; but of that much, so little would be in their favor that it is scarcely worth while to allude to them. Under this head, we would include, also, all the various mixtures containing coal-tar, pitch, &c., and going under the name of "*asphalt.*" To these, the term "poultice" has been applied by others than their advocates. According to Adolph Chess, C. E., the District of Columbia alone has $1,750,000 invested in various patent concrete and mastic and pseudo asphalt pavements, all of which are wretched and expensive failures. As the shortcomings of these soft, sticky, ephemeral pavements are frequently ascribed to *asphalt*, with which they have little or no connection, we had best consider at once what asphalt is; what it is not; and what are the qualities of a real or "rock-asphalt" pavement.

True rock-asphalt is a limestone saturated with about 12 per cent. of *asphaltum*, so thoroughly as to be hard, tenacious, elastic and waterproof. Asphaltum itself is an oxidized hydro-carbon, found iu Trinidad, Cuba, and other localities; it is tough, hard, and brown. While coal-tar softens or melts at 115° F., asphalt stands 170° unaltered. Tar decomposes readily; asphalt has stood all climates from Bombay to St. Petersburg, and is found in the walls of Babylon, to the preservation of which it has largely contributed. In France and Germany, foot-pavements and roadways made of rock-asphalt, disintegrated and mixed with free bitumen to form a mastic, have stood the severest test of climate and durability. They must be laid on even foundations: level hydraulic concrete being preferable. The material has the advantage over other compositions used, in being homogeneous. The uselessness of combining a hard material—as sand—with a soft medium—as coal-tar—possessing little or no permanence or binding power, need not be pointed out. The hard material is worked together, leaving the softer alone.

Roadways, as made in France and Germany, from Val-de-Travers or Seyssel asphalt-rock, are well worthy of our consideration. (1) Being smooth, hard, continuous, tough and elastic, they afford a minimum of resistance to draught, and wear of vehicles. (2) As regards security of foothold, asphalt, on levels or easy gradient, is sufficiently elastic and gives sufficient friction. Facing with clean, sharp sand or gravel improves it. When coated with sleet or thin ice, it is very slippery, and a horse finds it almost impossible to recover the erect position when once down.

Under ordinary circumstances, it has been observed that while one horse in 1308 falls on a paved street, but one in 1409 falls on asphalt. As the occurrence of a sleeted roadway is of infrequent occurrence, we may place asphalt as equal to stone in the matter of foothold on levels. On steep gradients, while affording a minimum of resistance to draught, it does not afford sufficient foothold, and hence must be discarded in such localities, unless used for wheel-tracks, with a central foothold of wood or other material. Guthrie recommends for such locations, a central track of pieces of lath-wood, dipped in melted asphalt, and laid on edge, inclined and overlapping. (3) The noise from an asphalt pavement is only a slight clicking from the horses' hoofs. The wheels give out no sound thereon. It is absolutely dustless, and hence produces no mud. Its wear on travelled streets, has been estimated at only from $\frac{1}{27}$ to $\frac{1}{25}$ of an inch per annum, and even this lessening in thickness, has, by some, been attributed to *compacting*, rather than abrasion or wear. Being absolutely impervious, it absorbs no unwholesome liquids, and gives out no noxious vapors; but is always sweet and clean after the removal of surface defilement. In this respect it deserves especial consideration. (4) It may be readily and thoroughly cleaned by scraping, sweeping or washing. (5) As regards durability, asphaltum, proper, has an excellent record. In Bordeaux, a life of 15 years is reported. Neither heat nor cold, attrition nor hammering, affects it. (6) Its facility of rapid and thorough repair is unequalled. It must, however, not be allowed to get out of order; small repairs should be made at once.

In London, 129 square yards per day were laid, as against 125 of the improved wood. In this latter city, the first cost of asphalt and granite was found to be the same—the expense of the repairs being greatest on the asphalt; but the latter lasts the longest, and the material of old roadways may be used again. In Paris, the asphalt cost $\frac{1}{3}$ less than granite, and the cost of maintenance was $\frac{3}{4}$ that of macadamized roads.

It will be seen that the preference in pavements lies among three species: one (rock-asphalt), as yet, untried in our country—(although asphalt in slight proportions, and adulterated and destroyed by other materials, has been laid and abused as "asphalt").

Denoting the rock-asphalt, the granite block, and the wood block, by the initials A., G., W., we find the order of superiority to be as follows:

Ease of traction,	A.	W.	G.
Minimum destruction of vehicles,	A.	W.	G.
Comfort to rider,	A.	W.	G.
Foothold to horses—dry,	W.	G.	A.
" wet,	A.	G.	W.
Freedom from noise,	A.	W.	G.
" dust,	A.	W.	G.
" mud,	A.	W.	G.
" exhalations,	A.	G.	W.
Facility of cleaning,	A.	G.	W.
Durability,	G.	A.	W.
Accessibility to pipes, and relaying,	G.	A.	W.

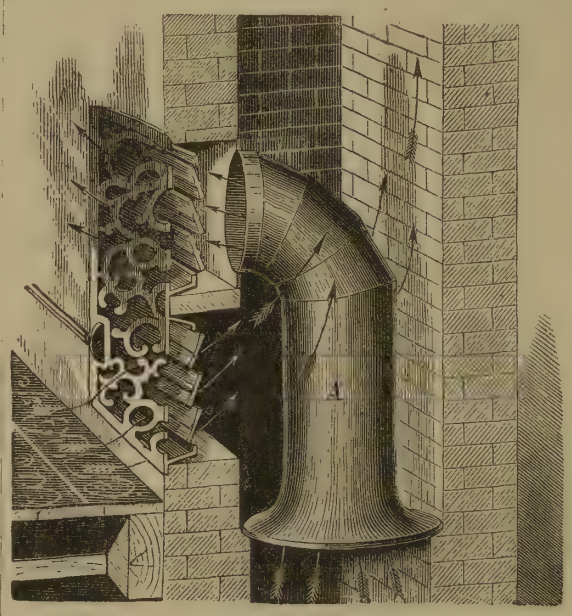
It would seem, then, from a careful recapitulation of the requisites of a good roadway, and of the qualities of the materials under consideration, that while for very heavy traffic granite-blocks would serve the purpose better, and on steep gradients wood is superior, for all other and general purposes pavements made from natural rock-asphalt, or from true asphaltum and hard fine gravel or sharp sand, would give the most satisfactory results in economy and comfort. We have near us plentiful and cheap supplies of the materials requisite to produce this superior roadway, and it is greatly to be hoped that few years will elapse before all our cities are paved and connected in a rational and creditable manner. †

A COMBINED HEATING AND VENTILATING APPARATUS.

Although the laws governing the circulation of atmospheric currents are satisfactorily understood, there is, we are "free to maintain," no subject upon which a discussion will elicit greater differences of opinion, than that of the heating and ventilation of buildings, and none in which successful practice may be predicted with greater hazard. So general and well-founded is this impression, that in numerous cases the ventilation of buildings is left to take care of itself, as a matter which at best could only be effectually realized by a fortunate accident, and the attention of the builder is bestowed simply upon the arrangements for heating. That this neglect of so important a sanitary measure is attended with serious consequences to the health, is beyond question; but, though the fact is admitted, there are so many opinions extant as to the most effectual remedial measures, that substantial reform in this particular may not speedily be anticipated. The difficulty, as we have stated it, consists in the establishment of a system which shall combine the comfortable heating of apartments with their thorough ventilation.

The apparatus herewith described, and with which doubtless some of our readers will be familiar, accounts of the same having appeared in several of the technical journals, has been deemed of sufficient interest to warrant the following mention by Dr. Benjamin Lee, in his recently published Report on Hygiene, made to the State Medical Society of Pennsylvania, on which account we reproduce the description in the Doctor's words: "In such a climate as ours, it (i. e. ventilation) is necessarily associated with the subject of artificial heat. The old idea was to admit fresh air at a low level in the room, and to allow it to escape at a high level. This, however, was found to be wasteful of heat, especially where the source of heat was a hot-air flue; as the warm air on entering, immediately, by virtue of its rarefaction, ascended to the ceiling and then escaped through the ventilating aperture, without having warmed the apartment, and leaving the air, which did not lie in the path of its current, cold and stagnant. Sanitarians, therefore, have been led to think, that, both for efficient renewal of the air and for economy of heat, the true plan is to have the foul air escape near the floor, as it is in that most effective of all ventilators—the old-fashioned open fire-place.

"In order to insure this result in houses heated by warm-air flues, a very ingenious device has been brought forward by Mr. George R. Barker, of Germantown. * * * * At about the level of the floor of the apartment the masonry hot-air shaft, in the chimney, is hermetically surmounted by a cylindrical tin or iron flue, somewhat diminished in diameter from the lower end for a short distance up, in order to leave a considerable space between it and the original flue-walls, and curving out to discharge its contents horizontally into the room. Immediately below its open mouth, terminating in a register, another register, entirely separate, although for the sake of beauty made in one piece with the first, opens into the primary flue. Now, what follows the entrance into the room of hot air from the supplementary flue? Simply this—that the warm air rises to the ceiling, becomes chilled, falls, and is distributed through the room, and finally, forced by the incoming stream of warm air, seeks an exit. This it discovers at the second register immediately below where it entered, having made



the complete circuit of the room, given up its heat, and taken in return whatever of impurity it could come in contact with, of a portable or diffusible character. Here it finds the necessary element of ascension, namely, a heated flue, and readily passes out and up. A complete circulation of the air of the apartments is thus secured, and at the same time the heat is all utilized."

The operations just described will be fully understood upon an inspection of the accompanying sectional view of the apparatus, in which the position of the supplementary flue, and the direction of the incoming and outgoing currents are clearly indicated. The volume of the outgoing (or ventilating) current will be regulated by the temperature of the supplementary flue and that of the contiguous walls of the flue proper; and may, furthermore, be largely increased or diminished, by opening or closing a valve within the small pipe, located on the top of the supplementary flue (not shown in the engraving). By the operation of this additional device, either a portion or the whole of the hot air may be thrown up the chimney, whereby the warmth, and consequently the draft of the vitiated air flue, will be increased accordingly. The utility of this device for crowded apartments, in which the heat often becomes excessive and the air very impure, is apparent. Mr. Barker's apparatus has been introduced into quite a number of public buildings in Philadelphia and its vicinity, and is protected by several patents. *

DATA WANTED.—The Mechanical Editor has been for some time collecting material bearing upon the subject of Fire Protection, including both Fire Proof Construction and Fire-Subduing Appliances, and requests all inventors, manufacturers, and others, having information upon these subjects, to forward him all attainable *data*.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

Hydro-Carbon Furnace.—In the *Scientific American Supplement, No.* 8, is described an "Improvement in Hydro-Carbon Furnaces, by J. C. Ramsden, Lightcliffe, Eng. In this arrangement, jets of steam playing into the fire-box are made to atomize volatile hydro-carbon; the mixture of steam and hydro-carbon burning with great intensity. Mr. A. G. Buzby and the writer successfully applied a similar contrivance (but using super-heated steam) to the Phœnix Steam Fire Engine, of Wilmington, Delaware, more than a year ago; and the "atomizing" device was *not* then a new one.

The Poughkeepsie Bridge.—The following is a brief description of the details of the proposed railroad bridge across the Hudson, at Poughkeepsie, for the consideration of which a contract has just been made with the American Bridge Company, viz.:

The main river bridge will be composed of five spans, of 525 feet each, from centre to centre of piers, each span having a clear width of 500 feet at water line. The river spans and approaches are to be built for two tracks, with sidewalks and iron hand-rails throughout, and when completed the structure will be what is termed an undergrade or deck bridge. The five river spans are to have each two trusses, 25 feet from centre to centre, built on the rectangular plan, with double intersections, constructed with iron and steel combined. The base of the rails, which will be of steel, will be 193 feet above high tide, and the top of the piers 135 feet, giving a depth of trusses of 58 feet. Approaching from the west, there will be a short span of 160 feet, composed of two trusses 30 feet high and 25 feet apart from centre to centre. Leaving the river spans on the east, the tracks will be supported by iron trestling consisting of three post-bents properly braced, and four lines of iron lattice stringers in spans from 20 to 60 feet, extending to Water street, Poughkeepsie. Water street and the grounds of the Hudson River Railroad Company, and also Dutchess avenue, are to be crossed by two spans having three trusses of 26 feet in height, and the remaining distance to the easterly side of Talmadge street will be upon iron trestling, excepting at Delafield and Talmadge street crossings, where the spans will be 90 feet each. The total length of the bridge and its approaches will be 4,500 feet.

The erection of the structure above described is understood to be a preliminary step to the proposed opening of a new line of railroad between New York and Chicago, which, it is affirmed, will be but 921 miles in length, or 59 miles shorter than the shortest existing route.

Mississippi Jetties.—With regard to the jetty works in course of construction at the mouth of the Mississippi, the history and description of which appeared in the February issue, we have the best authority for the statement that the works have now so far progressed that the results are beginning to appear on the bar itself, where 12 or 13 feet of water are reported.

Engineering Progress at the Centennial.—Among the many instructive historical exhibits which we are promised at the impending International Exhibition, not the least interesting will be an illustration of the development in the United States of engineering in all its branches during the past hundred years. We learn that the American Society of Civil Engineers has undertaken the task of preparing an historical exhibit of this nature, and has been alloted ample space for its proper illustration.

New Depot of the Pennsylvania Railroad Company.—We may record that work upon the new depot of the Pennsylvania Railroad Company in West Philadelphia, to take the place of its present structure on Market street above Thirty-first has already begun. The projected structure will stand back from Market street 130 feet, and from Thirty-second street 50 feet. The open space will be paved with Belgian blocks, so that carriages can drive up to the platforms. The plans are not yet perfected in all the details, but the following is a general idea of the building: It will be of two stories, constructed of brick. On the first floor will be a ladies' waiting-room, 40 by 100 feet; a general waiting-room, 80 by 100 feet, and a restaurant, 40 by 100 feet. In addition to which there will be smaller rooms for a ticket office, telegraph office, Pullman palace car office, depot master's office, newspaper stands, and retiring rooms. On the second floor will be the offices of the Superintendent of the Philadelphia Division and the General Agent of the Pennsylvania Railroad. There will also be two baggage-rooms for incoming and outgoing baggage. On the north side of the building will be a platform 50 feet wide for outward-bound passengers.

Two frame sheds will be built, each 800 feet long; one for incoming and the other for outward-bound trains. Three tracks will be laid in the former and four in the latter. Between the two sheds will be five tracks, called "wash tracks," on which the cars will be run when they are to be cleaned. It is the intention to run all the trains over the main line—the New York and Washington divisions—into one depot. This improvement will occupy all the space between the tunnel tracks and Thirty-second street. The two southernmost tracks will be used for main line trains, and from the depot to Overbrook there will be neither freight trains nor switches to interfere, with the exception of a switch at Mantua junction for New York trains. This will permit the highest rate of speed from the start. The arriving trains will unload their passengers on Thirty-second street. The building will cost $120,000, and is to be completed by May 1.

Life-Preserving Inventions.—The four accidents which occurred within about two weeks prior to the 10th of December last, occasioned by the locomotives jumping the track (viz.: three on the Pennsylvania Railroad—at Lawrence Station, Bergen Cut, and Delaware Bridge, and one on the Harlem Road at Woodlawn), by which property belonging to the railroad companies, amounting to $30,000 and upwards, was destroyed, and the lives of passengers endangered, would seem to indicate very clearly that some means ought to be devised, if possible, to prevent the occurrence of such accidents. Mr. William Halsted, of Trenton, N. J., has designed an invention to "greatly diminish, if not entirely prevent, the occurrence of accidents from this cause, and to effectually secure from danger the passengers who remain in those cars which have this invention attached to them, even if the locomotive should run off the track." Mr. Halsted has also invented a Safety Car-Coupling, "to prevent the locomotive running off the track; or, if in consequence of a broken rail, one of the wheels should get off the track, to prevent the locomotive from upsetting; and also to prevent the enormous loss of life and limb of employés engaged in coupling cars by the ordinary method. It appears by the annual report of Mr. Jewett, President of the Erie Road, that one hundred and eight of their employés lost life or limbs during the last year, while engaged in coupling cars."

These two inventions, as well as a "Locomotive Life-Preserver," the object of which is to push any human being or animal off the railroad, without fatally injuring them, Mr. Halsted offers without price to all railroads adopting them before the 10th of May next—the opening of the Centennial.

Monster Engines.—The pair of Corliss beam-engines, now erecting in Machinery Hall, Centennial Exhibition, are of 1400 H. P.; having cylinders 40 inch diameter, 10 feet stroke. The entire crank-pin circle will be above the floor and in view. The shaft carries a cut mortise-gear wheel 30 feet diameter, 24 inch face, having 216 teeth, of 5.183 inches pitch, and engaging a cast pinion, 10 feet diameter. The power is transmitted by miter-bevels and 6 inch shafting under the floor, to 8 points in the transepts. The miter-bevels are cut to geometrical exactness, and are 5 feet 10 inches diameter. The engines will run 35 revolutions per minute, giving the pinion and driving pulleys 105. The overhead shafting will run 120 and 240 revolutions per minute. Steam for these engines will be supplied by a battery of 20 vertical tubular boilers, brick-set, each 49 inches diameter, 14 feet long.

Torpedo Warfare.—The following is a brief abstract of a highly instructive lecture on the above subject lately delivered before the Franklin Scientific Society of the University of Pennsylvania, by Prof. Walter N. Hill, of the U. S. Torpedo Station, Newport, R. I.:

In this country the torpedo service is carried on at the station at Newport, which is under the control of the Ordnance Bureau of the navy, and at Willett's Point, N. Y., under the direction of the Engineer Corps of the army.

Torpedoes may be divided into those which are movable, or capable of being directed, and those which are confined in their action to the locality in which they are placed. The latter are evidently purely defensive in their character, and are used only in the defence of harbors, channels and rivers.

Men-of-war may carry torpedoes as part of their armaments. Such is the rule in our own navy. Every vessel fitting for sea is supplied with her torpedo outfit from the Torpedo Station at Newport, as regularly as with any other part of her equipment. With us the spar torpedo is the principal one used. This consists of a metal case, to contain the charge, attached to the end of a spar forty-five feet long, which swings out from the vessel's side, allowing the torpedo to sink beneath the surface of the water. By means of guys and a topping-lift the spar is kept in proper position.

The spar torpedo is peculiarly filled to prevent ramming—one of the most dangerous attacks to which a ship-of-war will be exposed. If used in conjunction with a small, swift steam-launch or cutter, it may be a most dangerous enemy. On the 17th of February, 1864, the powerful steam sloop-of-war Housatonic was sunk on the outer blockade off Charleston, by a spar torpedo from a small boat, and a few days later, off Charleston, the frigate Wabash, on discovering one of these little craft approaching, actually slipped her cable and ran away.

There are other varieties of the movable torpedo which have been successfully used, viz: The Harvey, or towing torpedo, the Whithead, or fish torpedo, one invented by an American, John L. Lay, and one by John Ericsson, of Monitor fame.

The simplest mode of defence by torpedoes is to place at regular and close intervals, all over the water to be protected, cases filled with explosive material (gunpowder, gun-cotton or dynamite), and provided with means of ignition of such a character that explosion occurs when the machine is struck by a floating object, like by a ship. They should be so placed that they will remain a short distance below the surface at all stages of the tide. The explosion, on contact, may be obtained by mechanical means or electricity.

American Tunneling.—Mr. Henry S. Drinker, M. E., of Philadelphia, is preparing "a general treatise on American Tunneling, to show both our record in the past, and the present methods in vogue." No such work has ever been compiled in America, and English records are meagre. Such a compilation, if accurate and full, would be of great help to engineers. Mr. Drinker desires reliable data, whether general or detailed, to aid him in the work.

Self-Registering Pluviometer.—Hervé Magnon has invented a device which records continuously, upon rolls of diagram paper, curves showing (1) the amount of rainfall, (2) varying intensities or temporary stoppages, (3) the length of time during which such differences or stoppages occur.

Railroad Train Accidents.—From the *Railroad Gazette's* record, it appears that there were in 1875, 1,201 railroad accidents in this country, 234 persons being killed, 1,107 injured. In 1874 there were 980 accidents, killing 204 and wounding 778. In 1873 there were 1,283 accidents, killing 276 and wounding 1,172. In 1875 there were 278 collisions, 840 derailments, 83 other accidents, being 3.29 per day. In 1874 there were 260 collisions, 654 derailments, 66 other accidents, being 2.68 per day. In 1873 there were 392 collisions, 815 derailments, 76 other accidents, being 3.51 per day. The number of accidents is proportionate to the severity of the winters.

"Consolidation" Engines.—The Pennsylvania Railroad is building 27 of these at Altoona.... *Steel Rails.*—The French Northern Railway requires steel rails to stand the following tests: when placed upon supports 43 inches apart, they shall bear in the middle of that space for five minutes, 1st, a pressure of 17 T without bending; 2d, a pressure of 30 T without bending more than .984 inches; 3d, shall support, without breakage, a blow of a weight of 6 cwt., falling 7 feet 3 inches. .... *The Hoosac Tunnel.*—425 men are replacing with brick dangerous portions of the rock arching; 90 yards of rock are taken out each day, and 47,000 brick laid; the arches being 20 inches thick..... *Locomotive Tire Heater.*—A vertical sheet iron furnace with arched top is closed round the tire, the wheel having been jacked up. Any fuel may be used.

Remarkable Pumping Engines.—The centrifugal pumps for draining the Ferrara Marshes in Italy, have a capacity of 656,640,000 gallons per day, or about 6 times that of the Croton Aqueduct. This water would form a stream 103 feet wide and 4 feet deep, flowing 2 miles an hour. The marshes cover 200 squares miles.

The Dynagraph is an ingenious device, recently introduced on the Lake Shore and Michigan Southern Railroad, for recording, on a continuous roll of paper, a diagram illustrating the resistances of engines, cars of different construction, and railway trains at all rates of speed, upon straight and curved, new and old portions of the track.... *Improvement in Engine for Twin-Screw Propellers.*—The condenser-chest and channel plate are made the engine-bed, on which are bracketed the cylinders and valve-chests, opposite and inclined to each other, with their respective crank-shafts and connecting-rods working under the opposite cylinders, the crank-shaft bearings being supported from the condenser and channel-plate..... *Safety Device for Cars.*—The object is to prevent the cars from leaving the road-bed should the wheels jump the rails or a rail break; to prevent travellers from falling under the wheels from the platform; to aid in stopping the train should the cars be de-railed. The car truck has two longitudinal runners, one on each side, outside the wheels, at the rail-top level, and grooved to fit the outer rail-flanges should the cars be de-railed.

MINING, METALLURGY.

Mechanical Puddling in India.—An experiment is about to be tried at the Royal Arsenal, Woolwich, England, which is regarded as of the greatest importance to the service in

India and to the Indian Empire in general. Throughout nearly the whole of India both coal and iron are to be obtained, but both of inferior quality, and hitherto the iron has not been utilized on account of its being almost impossible to puddle it, the climate forbidding the use of the ordinary puddling furnaces. Some iron has been made direct from the ore, but it has not proved satisfactory, and it is quite unavailable for military purposes. It is, therefore, desired to introduce some method of puddling by mechanical means, such as the arrangement known as Crampton's revolving furnace, which has been on trial at the Royal Gun Factories in the Royal Arsenal for some time past, and has been found to effectually decarbonize the metal without the employment of manual labor. The India Office has therefore sent over to England a quantity of native coal and iron ore, as well as some pig iron, with a view to an attempt being made to use the coal and puddle the iron on the revolving principle, and the trial will consequently be made in the Royal Gun Factories, under Mr. Crampton's own superintendence Should the experiments prove successful, many of the articles for military use, now manufactured in England and exported to India, will probably be made upon the spot by native workmen and of native material.

The Theory of the Puddling Process.—Mr. W. Mattieu Williams, in a recent lecture on the "Manufacture of Iron and Steel," delivered before the Society of Arts of London, advanced the following theory of the process by which the impurities are removed from pig iron in the operation of puddling. Mr. Williams is of the opinion that the removal of the silicon, carbon and manganese is effected, as is commonly held, by oxidation, but that the phosphorus and sulphur are removed by the simple rubbing or dashing of the granules of precipitated iron against the liquid cinder, as a laundress washes away the greasy impurities of fibrous fabrics by rubbing or dashing them in a solution of soap. In further elucidation of this theory, the lecturer explained that pure iron, which is infusible at puddling furnace heat, may be dissolved in a bath of fusible carbide, or silicide of iron, and that the sulphides and phosphides are both more fusible than iron itself. He contended that pig iron is a solution of pure iron in fusible compounds of iron, mainly the carbide and silicide; that when these are oxidized in the course of the melting and boiling, the infusible iron, with a certain quanity of still-adhering sulphide and phosphide, are precipitated as granules when the iron is "coming to nature;" that the puddler, by the agitation of his rabble, dashes these granules about in the liquid silicates, and thereby washes off the adhering and more soluble impurities, which pass into the cinder; and that the shingling, squeezing and rolling, are analogous to the wringing of the laundress, in removing the impurities diffused in the portion of liquid cinder remaining in the pores of the puddled bloom. In confirmation of this residual theory, he referred to the very vigorous efforts made by every good puddler, just at the moment the iron is precipitating, and while the granules are diffused in the liquid cinder, and to the well-established fact that the sulphur and phosphorus of the pig, pass into the cinder and are there found by chemical analysis.

This explanation was further elucidated by a comparison of the process just described, with the method by which crude paraffine scale is purified into the white paraffine wax, of which candles are made, by dissolving it in the liquid oil, with which it was originally fused, and washing it in this liquid as it reprecipitates, or "comes to nature," on cooling. [*Abstract from Iron.*]

Imparting Resonance to Alloys.—A process for imparting resonance to britannia metal, pewter, and other metallic alloys that usually give out a dull scund when struck, has lately been patented by Professor Silliman, of New Haven. It consists in submitting the metallic objects for a brief period to a bath of oil or paraffine, at a temperature just below the melting point of the alloy operated upon.

Quicksilver Production of California—The *Commercial Herald*, on this subject, makes the following statements:

The quantity of quicksilver produced on the Pacific Coast in the year 1875 amounted to about 54,000 flasks. This is wholly the fruit of California mines; none of the other Pacific States or Territories have yet made any quicksilver, though cinnabar in small quantities has been found in some of them. The total production of this metal throughout the world now reaches about 100,000 flasks, of which California is at present turning out fully one-half. In a few years more the yield of this State will be likely to greatly exceed that of all the world besides. The new Almaden mine produced in 1875, 13,648 flasks of 76½ pounds each, or 1,054,062 pounds in all; being an increase of 50 per cent. over the product of 1874.

What is Steel?—Sir Joseph Whitworth proposes to express the quality of steel by two numbers representing tensile strength and ductility; deeming that for constructive purposes ductility is of more importance than tensile strength, provided soundness is first obtained.

Iron Works of the United States.—The following is a summary of the prominent facts in relation to the iron industry of the country, as collated from a statistical pamphlet about to be issued by the American Iron and Steel Association, and noticed in its Bulletin of February 23d, viz.:

Whole number of completed Blast Furnaces, Jan. 1, 1876	713
Annual capacity of all the Furnaces, in net tons	5,439,230
Whole number of Rolling Mills, Jan. 1, 1876	332
Whole number of Single Puddling Furnaces (each double furnace counting as two single ones)	4,475
Total annual capacity of all Rolling Mills in finished iron, net tons	4,189,760
Annual capacity of all the Rail Mills in heavy rails, net tons	1,940,300
Number of Bessemer Steel Works, Jan. 1, 1876	11
Annual capacity in ingots, net tons	500,000
Number of Bessemer Converters	24
Number of Open-Hearth Steel Works, Jan. 1, 1876.	16
Number of Open-Hearth Furnaces	22
Annual capacity in ingots, net tons	45,000
Number of Crucible and other Steel Works, Jan. 1, 1876	39
Annual capacity of Merchantable Steel, net tons	108,250
Of which there are of Crucible Steel, in net tons	45,000
Number of Catalan Forges, making blooms direct from the ore, Jan. 1, 1876	39
Annual capacity in blooms and billets, net tons	59,450
Number of Bloomaries, Jan. 1, 1876, making blooms from pig iron	59
Annual capacity in blooms, net tons	60,200

CHEMISTRY, TECHNOLOGY.

Aniline Bronze.—Letters patent have lately been granted to Mr. Otto Fiorillo, of Baltimore, for an improved process of manufacturing aniline bronze, which consists, according to description, in the admixture of benzoic acid with aniline colors, for the purpose of producing a bronze paint or color, the shade or tint of which may be varied according to the aniline colors used and the treatment to which they are subjected.

To manufacture gold bronze, the inventor dissolves 10 parts of aniline red, or so-called diamond fuchsine or roseine, and 5 parts of aniline purple (known in commerce as "Hoffman's violet" or methyl violet) in 100 parts of alcohol of 95° strength, placing the vessel containing the mixture in a hot-water or sand-bath, to promote the dissolution. As soon as the aniline has been dissolved in the alcohol, he adds 5 parts benzoic acid, boils gently, then adds 32 parts of gum benzoin, and continues boiling from five to ten minutes, until the cantharide-green color of the mixture disappears, changing into a bright golden bronze color.

The color thus produced is affirmed to possess a very high lustre, and great durability, which will adhere firmly to paper, papier maché, wood, glass, tin, china, leather, and in fact, to nearly all substances. It is readily applied with a brush, and dries in a few minutes. It will answer its purpose equally well on white or colored grounds, and may be used, on account of its durability and the facility with which it is applied, upon ladies' boots, slippers, shoes, or other articles of leather, to which it imparts a bright golden bronze hue. It is said, likewise, that this paint or color adheres firmly to metal of every description, and may be used with advantage upon metallic articles of any kind used for ornamental or useful purposes.

A Scrap of History.—Our contemporary, *The American Gas-Light Journal*, has succeeded in unearthing an interesting contribution to the early history of gas-lighting in America. The historical scrap in question, which will be found appended, appears from its tenor to have been an advertisement inserted in the *Columbian Phœnix*, published in Providence, R. I., November 27, 1813, or three years before the first American Gas-Light Company was chartered to light the City of Baltimore, viz.:

The publishers, proprietors of letters patent from the President of the United States, for the IMPROVED GAS-LAMP, for lighting manufactories, mines, mills, theatres, light-houses, and other buildings, with hydrogen gas (*sic*!), or inflammable air, produced from pit coal, in a more agreeable, more safe, and less expensive manner than has hitherto been done by any other method, having it now in operation in a building in Newport, R. I., and in the cotton manufactory of Mr. Seth Bemis, in Watertown (seven miles from Boston), which is brilliantly illuminated every night with gas-light, to the exclusion of every other artificial means, they respectfully invite gentlemen concerned in manufactories, &c., to call and view it in operation, and be convinced of the utility and advantages of this improvement. The gas apparatus is very simple in its construction, and is so easy in its management, that any person of ordinary faculties may be taught in one or two operations to manage every part of it effectually, and the trouble will be found infinitely less than that of trimming and tending lamps or candles to afford the same number of flames.

The gas-lights are in no way expensive, but very agreeable to the eye, and will be found extensively useful in every situation where much light is required, especially in *cotton manufactories*, inasmuch as they are less expensive than those from tallow or oil, and free from the inconvenience and danger resulting from the sparks, and the frequently snuffing of lamps and candles; circumstances tending greatly to diminish the hazard of fire, and proportionably to reduce the rate of insurance on buildings and materials subject to that destructive element.

Contracts will be entered into for furnishing and putting up the apparatus in manufactories, &c., immediately, on terms highly advantageous, by applying to DAVID MELVILLE, Newport, or WINSLOW LEWIS, Boston.

N. B.—The gas apparatus has just been erected under the superintendence of the patentee, at the WENSCOTT MANUFACTORY (one and a-quarter miles from the Mill Bridge), which is now illuminated every evening with gas-lights. Gentlemen concerned in manufactories in this vicinity, are respectfully invited to call and see this valuable improvement in operation. An apparatus for any number of lights can be furnished in ten days after application, as above.

Providence, November 13, 1813.

A New Galvanic Battery.—A recent French invention for an alleged improvement in galvanic batteries, is described as follows: The pile is composed of a prism of charcoal, the pores of which are charged with oxide of iron and a small rod of amalgamated zinc. The apparatus is contained in a square glass jar, the zinc rod passing through the stopper, to the under surface of which the charcoal is attached. The exciting liquid employed is ammonium chloride. The reactions are the same as in the Léclanché's couple, in which oxide of manganese is employed. When the circuit is closed, the chloride of ammonium attacks the zinc, forming a double chloride of zinc and ammonium, which, on being formed, reacts upon the oxide of iron, robbing it of a portion of its oxygen, and forming free ammonia, which last disappears by evaporation. This pile ceases to act so long as the circuit remains open; its electromotive energy, as compared with the sulphate of copper battery, is as 12 to 10; it is said to be very constant, and well adapted for industrial uses.

A New Suggestion in Photography.—Professor Vogel writes to the *Philadelphia Photographer*, from Berlin, that Koenig, a physician at Paris, has constructed an apparatus consisting of a little drum, over which is stretched a very elastic skin. A stream of gas let through this drum will burn as usual, but as soon as a tune (by singing) strikes the skin stretched over the drum, the gas light commences to shake in a wonderful manner, and if its image is looked at in a rotating manner, peculiar figures are observed, which change according to the different notes emitted. By using a burning gas, giving a light of great chemical intensity, it is possible that these figures may be photographed. What kind of gas will answer best for this purpose appears to be yet undecided, but, affirms Professor Vogel, this much is certain, that there are in this respect great problems yet to be solved. We may succeed, perhaps, in photographing speeches, instead of reporting them stenographically as is now the custom.

Chemical Experiments with Magnets.—MM. Trève and Durassier, in the course of some experiments on the action of acids on magnets, arrive at the conclusion that magnetism, far from being confined to the surface, penetrates to the very centre of the steel. They affirm the conclusion that the penetration of magnetism into the entire mass of a piece of homogeneous steel, magnetized to saturation, is a general fact; or that the magnetism, at first superficial, penetrates successively into the mass, in proportion as the outer layers are dissolved away by an acid.—*Chemical News.*

Practical Uses of Light.—Dr. Crookes suggests that the torsion balance (used in testing the amount of action caused by the approach of light to it) should be employed as a gas-test; and also in meteorological observations, to note and record the amount of light falling at any place.

Treating Wood.—A new process consists in saturating the wood with moisture (preferably by steaming) and rolling it repeatedly (keeping moistened), so as to increase its length and decrease its thickness. Great ductility and flexibility are acquired, with a general consistency approaching that of leather. It is preferable to pass the strips through the rolls diagonal to the grain.

Steam Brick-Kiln.—By recent improvements bricks may be burned uniformly of any desired color and hardness, at half the usual cost, and in half the usual time. Two platting courses of hard bricks are closely laid on the platting course of green bricks, to retain the heat. A $\frac{3}{16}$ inch jet of steam at 65 lbs. pressure is let into each furnace over the fire-doors, increasing the draft, consuming the smoke, and carrying and evenly distributing the heat to all parts of the kiln. Coal dust

and petroleum are used as fuel. The grates are cast iron plates with perforations ⅜ inch on the upper side, ½ inch on the under, to prevent clogging. The bricks are dried in 11 hours, burned to a handsome color in 36 hours (the usual time being 4 to 10 days). It is not necessary to burn 100,000 common bricks to get 10,000 pressed bricks; but an entire kiln of 200,000 red or pressed bricks may be burned uniformly, and with unskilled labor.

MISCELLANEOUS.

Fig. 2. Fig. 1.

THE cuts show Prentiss' Paving Block, patented December 21st, 1875. Fig. 1 is a chilled iron frame one foot each way, corrugated on the top, with a bolt and nut attached to the centre. Fig. 2 is the frame filled with asphalt, concrete, or any other suitable composition, allowed to harden so as to make a solid block, with iron top and corners, bolted firmly together. It is claimed that this will make a pavement having every requirement in the article on "Roadways" in this issue.

The United States Patent Office.—The following table is prepared from the Annual Report of Hon. R. H. Duell, Commissioner of Patents, for 1875:

Years, inclusive.	Applications.	Caveats Filed.	Patents issued.	Per cent. of Applications Refused.	Per cent. of Applications Granted.	Proportion of Patents.
1837–45	.....	.....	3,898	.....	.....	Those in 1839 being unity
1846–55	23,908	7,236	10,689	55.3	44.7	
1856–65	52,264	10,450	41,146	21.1	78.9	
1866	15,269	2,723	9,450	38.1	61.9	22.2
1867	21,276	3,597	13,015	38.9	61.1	30.6
1868	20,420	3,705	13,378	34.5	65.5	31.4
1869	19,271	3,624	13,986	27.5	72.5	32.9
1870	19,171	3,273	13,321	30.6	69.4	31.3
1871	19,472	3,366	13,033	33 1	66.9	30.6
1872	18,246	3,090	13,590	25.6	74.4	31.9
1873	20,414	3,248	12,864	37.	63.	30.2
1874	21,602	3,181	13,599	37.1	62.9	32.
1875	21,638	3,094	16,288	24.8	75.2	38.3
Totals.	272,951	50,587	183,257			

From the above it will be seen that the past year was an unusually favorable one for inventors, not only in the number of patents issued, but in the percentage of applications granted. This may be attributable in part to a change of policy on the part of the Patent Office, and in part to *careful preparation of the applications*. The importance of employing reputable patent solicitors of ability and experience, cannot be too highly estimated.

Philadelphia Fire Record.—The report of the Fire Marshal for the year 1875, places the total number of fires during the year at 669, involving a loss of $1,193,970.05, on which there were insurances to the amount of $6,545,789.92; the insurance over loss being $5,351,819.97. Compared with the losses of the year 1874, there is an increase of $454,272.79.

The fires resulted from the following causes: Carelessness, 392; accidents, 156; incendiarism, 15; attended with suspicious circumstances, 13; fireworks, 25; spontaneous combustion, 3; accidents from use of coal oil, 53; lightning, 2; explosions, 1; accidents from gas, 6; unknown, 3.

THE report is circulating that it has just been decided to light all the waiting and luggage-rooms of the principal railway stations in Paris by means of electricity.

Accidents from "Non-Explosive" Oils.—We have lately noticed with satisfaction the record of a decision by the Supreme Court of Louisiana, affirming the liability of advertisers of "non-explosive" oils for damages, in the event of accident or injury resulting from their use. The petroleum inspection laws of this State, which, if properly enforced, might afford a very reasonable degree of security to the users of burning oils, have proved in practice (which introduces the personal equation) so utterly inefficient as to be generally admitted to be worthless. Perhaps the prosecution of unscrupulous compounders of benzine mixtures and "combinations" may lead to something more tangible in the way of protecting life and property.

Annealing Wire.—A recent invention employs a current of electricity as the heating agent.

Nationality and Disease.—Deaths from alcoholism are principally among foreigners, in the following order of nationality, England, Ireland, Scotland, Germany. The consumption rate is greatest in the Irish, least in the English. Apoplexy and nervous diseases generally: largest percentage among the Scotch, least among the Irish. In diseases of the digestive organs, Ireland gives the largest percentage of stomach diseases, and least of diseases of the bowels. There are no Irish and Scotch suicides.

Ice Machines.—The Hudson ice crop is a failure, and good ice machines would doubtless pay next summer.

BIBLIOGRAPHICAL NOTICES.

We acknowledge the issue and receipt of the following publications:

Astronomical and Meteorological Observations made during the year 1873, at the United States Naval Observatory. Rear-Admiral B. F. Sands, U. S. N., Superintendent. Published by authority of the Honorable Secretary of the Navy. Washington: Government Printing Office, 1875; and the Annual Report of the Supervising Architect to the Secretary of the Treasury, for the year 1875. Washington: Government Printing Office. 126 pp. 12mo. 23 full page illustrations.

REPORT OF THE GEOLOGICAL SURVEY OF NORTH CAROLINA. Vol. I. Physical Geography, Resumé, Economical Geology. W. C. KERR. By authority of the General Assembly. Raleigh: 1875. (8mo. 326-120 pp.)

From the historical sketch with which the above volume is prefaced, it appears that the present survey was inaugurated in the year 1866, and that the present report was offered to the Legislature in 1870, but no appropriation was made for its publication, until at last, after having remained shelved for more than three years, it was published under a permissive resolution, out of the working fund of the survey. Materials for a second volume are in hand, and we are informed will be put to press during the present year.

An introductory chapter affords a geographical description of the State, a resumé of its statistics of population and industries. From this we glean, that owing to the inaccuracies of the ancient surveys, dating from colonial times, since which little has been done to correct them, the only portion of the State boundary which is known, or ascertained with any thing like accuracy, is the eastern or oceanic, and a small portion of the western. These inaccuracies appear to have cost the State many hundreds of square miles of territory, and to be the cause of much litigation, for which reasons the necessity for the determination of the State boundaries with scientific precision is urged as a pressing necessity. Chapter II affords an interesting description of the physical geography of the State, including its general topographical features, supplemented by an extended table of elevations of numerous prominent localities, and a discussion of its climatology, botany and zoölogy. Chapter III is a brief treatise on systematic geology. Chapter IV gives an outline of the geology of the State, which is illustrated by a well executed colored geological map accompanying the work.

A large portion of the volume is devoted to the economical geology of the State. Much valuable information is afforded concerning the soils, the marls, peat, muck, and other fertilizers, followed by a full description of the valuable ores and mines of the State, of which iron, copper and gold are the most important and valuable, and a section concerning the useful minerals—not ores—including coal, graphite, serpentine, corundum, mica, &c. Concerning the last-named product, an interesting account is given of the occurrence of numerous ancient workings, supposed to be evidences of the operations of the mound builders, and contemporaneous with the extensive copper mining operations of very ancient date, that have been discovered in the Lake Superior region.

Four appendices are attached to the volume. Appendix A, by T. A. Conrad, gives descriptions of new genera and species of fossil shells of North Carolina, in the State Cabinet at Raleigh; B, by Professor E. D. Cope, is a synopsis of the fossil vertebrate found in the State; C is an admirable synopsis of the mineralogy of the State, from the pen of Professor F. A. Genth; and D, an account of the occurrence of corundum and its associated rocks, by Rev. C. D. Smith.

Besides the colored map above referred to, the volume is illustrated with eight handsomely engraved lithographic plates, belonging to the paleontological appendices.

The report, despite the fact (alluded to by the author in his preface) that the work of the survey was conducted with an appropriation utterly inadequate to its importance, and in the face of many untoward circumstances and disheartening obstructions, is a very creditable one, and will be found invaluable as a work of reference by those who are seeking for reliable information concerning the wonderful mineral resources of North Carolina—a subject that is attracting much attention outside of the State.

THE ELEMENTS OF PHYSICAL GEOGRAPHY, FOR THE USE OF SCHOOLS, ACADEMIES AND COLLEGES. By Edwin J. Houston, A. M., Professor of Physical Geography, &c., in the Central High School of Philadelphia. Philadelphia: Published by Eldridge & Brother, No. 17 N. Seventh Street. 1876.

We have rarely met with a text-book that has answered the promises of its preface so well as this one. The author, while adhering generally to the customary standard divisions of his subject, has elaborated many points of interest in relation thereto, which in previous works of the kind are passed over with the briefest comments or allusion; while here and there we observed with satisfaction the absence of memory-burdening details, with which kindred works are too frequently encumbered. The style of the author is lucid and concise, and wherever explanations are attempted the matter given is an explantion, and not a re-statement in other terms of the thing to be elucidated. In this connection the author's remarks in the reference to the cause of the earth's orbital motion (p. 10), the wherefore of the change of seasons (p. 15, *et seq.*), the theories respecting the condition of the interior of the earth (p. 21), the transporting power of rivers (p. 60, *et seq.*), the tides (p. 70, *et seq.*), the paragraphs on hail (p. 99), and the chapters on the winds and on meteorology, are specially deserving of notice. The author's thorough familiarity with physics and geology is abundantly demonstrated throughout the work in the scientific accuracy, originality and clearness of the descriptive and explanatory matter, in the notable absence of the trash and errors that in many similar works have almost become stereotyped by repetition, and in the introduction of the results of recent discovery and investigation—witness, a description of the working system of the Weather Bureau at Washington.

The work is very fully illustrated, and its value is materially contributed to, by a number of maps and charts explanatory of various subjects treated of, some of which have been reproduced from standard works on physics and geology, while others have been specially prepared by the author. The book is admirably printed on good paper, is neatly and substantially bound, and altogether reflects credit on its author and publishers.

STATISTICS OF MINES AND MINING IN THE STATES AND TERRITORIES WEST OF THE ROCKY MOUNTAINS. Being the Seventh Annual Report of Rossiter W. Raymond, U. S. Commissioner of Mining Statistics. Washington: Government Printing Office. 1875. 540 pp. 8mo.

The above volume, uniform in size with the preceding volumes from the same author, has just been issued from the Government Printing Office. These works have come to be looked upon as standard contributions to the history and development of the mining industries of our country, and each succeeding volume is, if possible, more valuable than its predecessor. The present volume contains, in addition to much statistical matter, a number of valuable scientific papers read before the meetings of the American Institute of Mining Engineers.

A BILL is before the legislature of the State of Pennsylvania to establish industrial schools. The plan proposed is to divide the State into three industrial school districts, the first of which comprises the City and County of Philadelphia, and the Counties of Delaware, Chester, Montgomery, Bucks, Adams, York, Lancaster, Lebanon, Berks, Lehigh, Monroe and Northampton. In each of these three districts there shall be established a school or schools for the education, teaching, and training of the youth of this commonwealth in the practical application of the sciences, in connection with arts, agriculture, manufactures and commerce. Said schools shall be under the absolute control of the commonwealth, constituted within the system of public schools, maintained and supported as part thereof.—*Trade Journal.*

THE GOVERNMENT DISPLAY AT THE INTERNATIONAL EXHIBITION.

It is satisfactory to find among many notices of the coming Centennial, in the foreign magazines, a detailed plan and description of the splendid building which our government has erected for the exposition of public memorials and landmarks of our national progress. This building, having been erected subsequently to those which had been, at first, proposed in the ideas of the Centennial, has, so far, attracted less attention.

The different departments of the government will be represented, each, we believe, very fully and handsomely, unless we except the State Department, in regard to which it is to be inferred, from the nature of its office as so largely confidential on international and historic matters, there cannot well be an exposition.

We have space in this issue only to say further that the building is rapidly receiving government objects in its inside and outside sections, and that a large number of articles of a specially illustrative character are being packed at the different offices, forts and yards, under orders from the Bureau of the War and Navy Departments, the Interior, the Post Office and the Smithsonian Institution, for transportation to Philadelphia.

Among other exhibitions, the Naval Observatory will have upon the grounds a set of buildings just like those used by the American parties who went out to both hemispheres to observe the transit of Venus, of December 8-9, 1874. These buildings put up in sections will show, in their construction and in the mounting of the instruments within them, an adaptation peculiarly American, and superior to that noticed by the foreign observers whom our light parties met abroad in 1874. It is expected the Observatory will show in them, upon the Centennial Grounds, the actual mode in which the observations were taken. The instruments are an equatorial, a transit, and photo-heliographic apparatus.

Besides this scientific exposition, and besides the exhibition of complete sets of all the Observatory publications to date, we learn, on inquiry, that there will be an interesting collec-

tion of objects illustrating our several Arctic expeditions. The friends of the explorers and the naval officers sent out in the relief ships—the Tigress and the Juniata, as well as the Congress—are responding, we learn, very cordially to the invitations of the Observatory sent out by Admiral Davis. It is desired to receive the fullest answer from all parties who are willing to loan to the care of the Observatory objects illustrative of the work of Kane, Hayes and Hall. That work is a credit to our country. It is availed of by the British expeditions now following in the very tracks of our American heroes.

The part that will be taken by the Smithsonian Institution, furthermore, promises to be of unusual interest and value. The exhibits of the Institution will be divided into four classes, one of which will represent the mineral resources of the country, another her animal resources, a third her fishery resources, and a fourth, ethnology. It is designed that these collections, after having served their purpose at the International Exhibition, shall be transferred to Washington, and form part of the National Museum, where they will remain on permanent exhibition. The Institution has cordially invited the co-operation of patriotic citizens throughout the country, to the end that the display shall be as complete and representative as possible.

With reference to one of the most instructive and interesting portions of the proposed Smithsonian display, we have just received the following communication, which we commend to the perusal of our readers, viz. :

Editors of POLYTECHNIC REVIEW, *Philadelphia :*

SIRS:

The Smithsonian Institution proposes to exhibit in the government building at the forthcoming International Exposition, a series of illustrations of the resources of the United States, as derived from the animal kingdom, and will show suitably prepared specimens of the animals themselves, as also their applications in the arts or for purposes of luxury and ornament. Thus, in connection with the fur-bearing animals, there will be exhibited a series of prepared furs, and a few articles of dress, showing their appearance when made up.

Hides of the various species will be accompanied by specimens of the leather in different stages of preparation, and some of the articles made out of it.

The uses of the bones and teeth will be illustrated by a series of carvings and other objects. The various applications of whale-bone, of tortoise shells, of shells of pearl, and the *unio*, of fish scales for ornamental purposes, etc., will all be included in this series.

We shall be pleased to receive contributions from any manufacturers of such articles in Philadelphia, and to exhibit small series of the same in the Smithsonian display, of course, to be duly credited to the donor, both on the label and in the catalogue. To those who intend to exhibit in the main building, this will afford a double advertisement.

We cannot accommodate large series of any group, but merely wish samples. As stated in the circulars which I send you herewith, these specimens will all, ultimately, be transferred to Washington and form part of the permanent display of the same character, which it is proposed to establish in connection with the National Museum.

Respectfully yours,

* SPENCER F. BAIRD.

A Man's Work.—Frequent rests and cadence increase a man's capacity for work. Leg-power is the most effective. The heaviest weight a strong man can carry a short distance averages under 319 pounds; all he can carry habitually on level ground is 132 pounds, or an aggregate of 1,518 pounds, 3,200 feet high per day. A hod-carrier carries under 121 pounds continuously; his day's work being 1,232 pounds, 3,200 feet high. The maximum arm-power is 26.4 to 33 pounds, raised 1.8 to 2.1 feet per second, equalling about $\frac{1}{8}$ horse power.

Gloucester Iron Works.—Correction.—There was an error in the advertisement of the Gloucester Iron Works, as it appeared in our February number—the descriptive matter having been omitted. The card as appearing in this number on the first cover page (which see) is correct.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

FRANKLIN INSTITUTE.—At the stated meeting, February 16, a circular communication from the Boston Society of Civil Engineers, with the avowed object of securing the united action of all organizations throughout the country in petitioning Congress to fix a date after which the metrical weights and measures shall be adopted as the legal standard, was referred to a committee, consisting of Wm. P. Tatham, Coleman Sellers, and Robert Briggs. [The communication appeared on pages 3 and 4 of the REVIEW for February.] Samples of vulcanized (paper) fibre were exhibited. Mr. Emile Geyelin read an able and interesting paper (illustrated by stereopticon and paper diagrams) upon "The Action of Turbine Wheels under Part Gate." [This is reserved for full publication, with illustrations, in our April number.] A vote of thanks was tendered to J. S. Albert, Chief of the Bureau of Machinery of the Centennial Exhibition, for having provided and tendered pleasant and commodious quarters for the use of the members of the Institute.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—The 190th meeting of the Society of Arts was held February 10th.

Mr. S. W. Holman presented, in behalf of the inventor, Mr. George Iles, of Montreal, a new form of mariners' compass, called a Differential Compass, designed to detect variations of the compass needles, due to the disturbing action of iron ships, and thus to obtain the magnetic north. Mr. Holman explained and illustrated with magnets the effect upon a compass of the iron mass of a ship. Heretofore the correction of these variations, often amounting to 30° or 40°, and not constant, has been impossible. The model consists of two compound needles, pivoted one above the other. The upper needle is a series of bundles of small magnets, held between two long aluminium strips, and with their like poles pointing in the same directions; the north pole of one towards the south of another. As each small bar can be much more intensely magnetized in proportion than a large one, we obtain a needle more intensely magnetized than an ordinary bar could be. The different distribution of magnetism through this needle and an ordinary bar was shown by means of iron-filings upon a screen. The lower compass needle is made up of similar bundles of small steel bars between aluminium strips, with like poles all on the same side of the needle, and producing a compound needle sitting east and west.

Thus, when pivoted one above the other, the needles sit at right angles. A piece of soft iron or an attractive magnet, introduced into any quadrant near the needles, diminishes the quadrant to an acute angle; or, if introduced at a distance, would decrease it from a quadrant, which could, under prescribed conditions, be restored by the repellant pole of a compensating magnet.

Mr. Holman showed that (from experiments performed by him in the laboratory upon the compass) disturbing action at a distance had not the effect that Mr. Iles had expected, an acute angle being produced *only when the disturbing cause was at a small distance from the needles, compared with the length of the small component magnets.* The compass showed no variation from the right angles between its needles, when a disturbing magnet had widely swerved them both from a true position. Mr. H. then showed, on theoretical grounds, the reason for these two actions at different distances, showing the fallacy of the instrument, which had been widely patented and exhibited in many places and before scientific societies, thus acquiring a wide reputation.

A paper was read from the late T. Willis Pratt, C. E., regarding a design for a tower of great height, intended for the Centennial. It had been proposed to build this 1000 feet into the air—more than double the height of any existing human structure. [The top of the statue on the tower of the Philadelphia Public Buildings will be 510 feet above the pavement.] Although this plan was abandoned and one of more modest proportions substituted, some engineering points of interest in regard to high towers were evolved by Mr. Pratt.

There was to be a central cylindrical tower, 30 feet diameter, 1000 feet high. Around the interior was to be a staircase; in the quadrants of the inner circular space were to be elevators. Outside the cylinder was to be a network of Pratt trusses, like huge ladders with diagonal braces between the rounds, and connected together in a circle surrounding the central portion; this exterior framework to be 150 feet diameter at the base, tapering to meet the cylinder at the top, and to be connected with it at intervals by iron tie-rods, thus bracing it in all directions.

There are four kinds of occurrences which, happening in excessive force, could disturb the stability of so high a tower —*earthquakes*, *lightning*, *wind* and *heat*. The first would doubtless give it a severe trial, depending upon the amount of vibration given; but if properly built of iron it would stand more severe shocks than if of brick or stone. It is, however, mere guesswork to anticipate the occurrence or the power of an earthquake.

As regards lightning, the tower would be a lightning-rod; should have sharp points at the top, projecting in all directions, and proper moist earth communications. With these precautions no danger from lightning need be feared.

The tower is stated to be able to resist a wind with a pressure of 50 lbs. to the square foot (rated as a hurricane moving 100 miles per hour). Being circular, it would not present as great surface resistance as a plane 1000 feet by 30; but allowing for the exterior work of columns, struts and braces, we may assume that the surface equals 30,000 square feet. 50 lbs. per square foot would be 1,500,000 lbs. The centre of this pressure would be 500 feet above the base. The centre of weight would be in the centre of the base, 75 feet from the edge. Assuming this pressure to act horizontally on the long arm of a bent lever 500 feet high, with its short arm horizontal and 75 feet long, we would have 10,000,000 lbs. lifting power. If the whole mass weigh that much, or more, such a wind would throw that amount of weight on one side only, upon not more than two of the outer columns at first, as they are arranged in a circle, and they must yield in detail, and the tower be overturned.

Concerning variations of temperature. We shall assume (from other observations) that on a bright, sunny day, during a heated term, there will be a difference of 30° F. between the sunny and shady sides. The direct sun-rays will heat dark-colored iron to 120°, when the heat in the shade would be 90°. The sunny side would become 2½ inches the longest. The top would be thrown 32 inches out of plumb. If this were in the morning and the opposite side be expanded in the afternoon, the total movement would be 64 inches, being very slow and uniform, and almost imperceptible. Bunker Hill Monument, of stone, 220 feet high, 30 feet at base, is thus affected by the heat. The proposed tower is nearly five times the height, and being of iron would be proportionately more affected. If it were painted white, the effect of the heat would be much less.

The Secretary read an abstract of his annual report, showing the variety and importance of the subjects which had been brought before the Society of Arts during the last session. These subjects were as follows: On the "Maury Lanes, or the Best Tracks for Atlantic Steamers;" on the "Apparatus for Saving Life at Sea;" on "Artificial Stone;" on the "Indicator Diagram and its interpretation," the result of many years' study by Mr. J. C. Hoadley, of Lawrence, and of great interest to engineers; on "A New and Speedy Process of Drying Lumber;" on "Automatic Electric Railway Signals," substituting an interval of *space* instead of an interval of *time* between railroad trains; on the "Automatic Regulation of Heat and Ventilation;" on "Tests of Various Apparatus connected with Steam Engineering," by students of the Institute; on "Boiler Explosions, and their Causes;" on "Papered Wood-Hangings;" on the "Governing Principles of the Screw Propeller;" on an "Automatic Electric Burglar Alarm;" On the "Type Writer," to supersede the pen in manuscript writing; on "Cylinder Condensation, and the Means of Suppressing it," the result of several years' experiments, verified in the mechanical laboratory of the Institute, a paper of great interest and practical importance to steam engineers, on the ground of economy and increase of power.

MANCHESTER (ENGLAND) SCIENTIFIC AND MECHANICAL SOCIETY, FRIDAY, *January* 28, 1876.

The Construction of Street Tramways.—At the meeting of above date, Mr. J. Bowes read a paper on "The Construction of Street Tramways, with suggestions for a new section of rails and fastenings for the same." The author urged that the chief requirements of a good, serviceable tramway are, (1) that the rail and its fixings should present as small a surface of iron or other slippery material on the face of the pavement as possible; (2) that the rail should be of such a form as would give it the greatest strength vertically for the quantity of material in it; and (3) that its strength should be sufficient in itself to prevent deflection, which not only caused a greater amount of traction to be required, but also loosened the fastenings, and in other ways tended to destroy the efficiency and durability of the tramway. He described what he called the girder tram-rail, which was a rail and girder combined, in which, he claimed, the material was distributed in the proper shape for carrying a vertical pressure or moving weight, viz., the girder shape. This form of rail, he affirmed, also gave better facilities for connecting the rail ends than any other he had yet met with, an important feature in the formation of a strong, serviceable road.

EDINBURGH AND LEITH ENGINEERS' SOCIETY.—At the last meeting Mr. James Blyth read a paper on the "Flow of a Perfect Fluid through Pipes." It was shown that when a perfect fluid flowed uniformly through a pipe of varying section, the pressure varied in proportion to the area of the section. An experiment was made to show that water projected under pressure from one small orifice, and received by another one in the same line, and at a short distance, was able to rise to almost the same head as that from which it originated. The author showed how a body completely immersed in a perfect fluid would meet with no resistance if it moved uniformly; the chief resistance to a ship's motion arising from skin-friction and formation of waves.

Wagner Free Institute of Science.—In consequence of the damage to the hall of this Institute, occasioned by the recent storm, the stated meeting of February 12, and the special meeting of the 19th, as well as several of the lectures, were omitted. The next regular meeting will be held March 11. (See advertisement, third page of cover.)

☞ *Secretaries of Societies* are requested to send reports intended for our April number so that they may be received not later than March 20.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. I. PHILADELPHIA, APRIL, 1876. NO. 3.

[OFFICIAL.]

THE NEW GOVERNMENT BUILDING, PHILADELPHIA.

The accompanying engraving shows the new government building for the accommodation of the Post Office, United States Courts and government offices at Philadelphia, as it will appear on completion. This structure is located on the portion of the square bounded by Ninth, Chestnut and Market streets, having a frontage of 430 feet on Ninth, and 155 feet on Chestnut and Market streets. The three fronts, which are in the *Renaissance* style, are treated with great regularity with four stories of pilasters and columns throughout the whole length. The height from ground to top of main cornice, is 90 feet; and from ground to top of the dome, crowning the central portion of the Ninth street façade, 180 feet. The material used for the front is granite, the Old Dominion Granite Co., of Richmond, furnishing the stone for the basement and lower portion of the first story, and the superstructure to be of Maine granite furnished by the Dix Island Granite Co.

The basement is to be occupied for Post Office purposes, heating apparatus, fuel storage, &c. The entire first floor is devoted to the Post Office, with the main business room, 140×254 feet, well lighted by windows in the exterior wall, and an immense skylight 62×254 feet. Large rooms are also given on this floor for money order office, Postmaster, Cashier, &c. The public corridor extends along the Ninth street front, where are located the main entrances for the public. The driveway for mail wagons is located at the rear of the building. The second story is assigned entirely for various government offices. The third story is devoted entirely to court purposes, with large court rooms, 42×63 feet, and about 30 feet high. Ample accommodation is given on this floor for Judges, District Attorney, Clerks of Courts, Marshal and other court officials. The fourth floor is divided up into jury rooms, apartments for route agents, document and file rooms, &c.

The heights of the various stories are as follows: basement, 15 feet; first story, 27 feet; second story, 22 feet; third story, 20 feet; and fourth story, 16 feet. A large passenger elevator at each end of the building gives easy access to the upper stories, and freight elevators are located in the Post Office for transmitting mails to the basement. The stairways and corridors throughout are of liberal dimensions. Each story is well supplied with closets and lavatories. Two large air shafts, enclosing the smoke-flues from boilers, insure proper ventilation—ducts connected with them opening into the various rooms. The interior walls are all of brick, and the roof and floors intended to be fireproof.

The New Government Building, Philadelphia.

MODERN FIRE ENGINES.

III.

Messrs. Shand, Mason & Co., of London, England, very kindly send us drawings and descriptions of the "Inclined Water-Tube" boiler used on all their Steam Fire Engines.

"The boiler is constructed in two pieces, bolted together by an angle-iron faced joint, which affords immediate access to the whole of the interior, but on account of the rapid circulation of water in the tubes, this feature, although retained, is not found necessary in practice.

"Bowling iron only is used, with the longitudinal seams welded, and all holes, whether for rivets or bolts, are drilled and not punched. The tubes are of homogeneous metal, and as the pressure is inside, and the ends are removed from the hottest part of the fire, no leakage whatever takes place, while the complete through passage in the tubes, combined with their inclined position, prevents the accumulation of deposit, which in practice invariably takes place in tubes where one of the ends is closed.

"The cylindrical tube-plate and the tubes, being exposed to equal amounts of heat, it follows that the diameter of tube-plate increases by expansion to exactly the same extent as the tubes lengthen, so that no displacement of the ends of the tubes can take place from alternate expansion and contraction.

"The fire-box is surrounded by a water space, which economises fuel, and avoids the necessity for a lining of fire-bricks and fire-clay, the replacing and keeping in order of this being in some Steam Fire Engines a fruitful source of annoyance.

"The working steam pressure of Shand, Mason & Co's engines in the Metropolitan Fire Brigade, is 100 lbs. on the square inch. Steam of 100 lbs. pressure can be raised in 6 minutes 35 seconds from lighting of fire. A Giffard injector is supplied, as well as the ordinary feed-pump.

"Figure 12 is a sectional elevation of boiler; figure 13, an elevation of absorption chamber; figure 14, a plan of same.

"A, the furnace; B, the absorption chamber sectioned on the line I, J, figure 14; C, the chimney or funnel; D, the outer shell; E, the steam chest; F, the narrowest part of eccentric water space through which the tubes are supplied with water at their lower ends; K, the widest part of eccentric water space through which the upper ends of the tubes deliver the steam produced from the heat absorbed by the tubes, and transmitted to the water during its passage through them. By the arrangement of tubes shown at G, figure 13, and at H, figure 14, and water spaces shown at F and K, figures 12 and 14, a general circulation of water is obtained in the boiler, and especially through the tubes, while the water space at K, increasing upwards, allows of an easy separation of steam from the accompanying water, and of its rising into the steam chest separated, thus materially preventing priming, while the water returns to the lower ends of the tubes, thereby maintaining a constant circulation through them in the direction shown by the arrows, and by crossing the tubes in alternate layers, a constant flow towards and into the lower ends of tubes is induced, and a constant discharge from the upper ends throughout the other half, thus causing general and uninterrupted currents of water and steam."

FIG. 12.

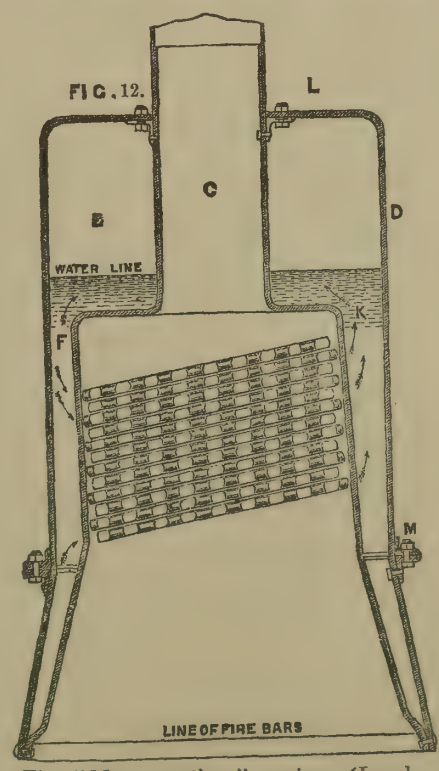


FIG. 13.

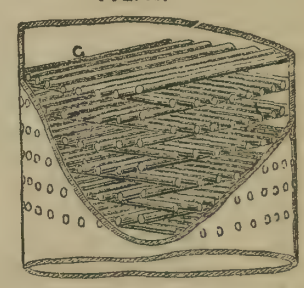
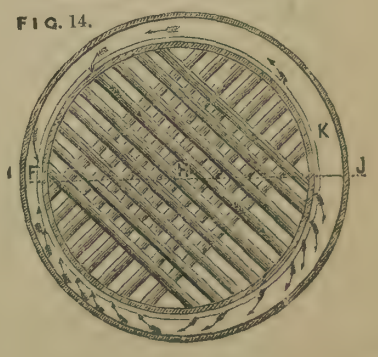


FIG. 14.



The "Merryweather" engines (London) have a tubulous boiler with suspended water-tubes somewhat similar to those in the Silsby boiler, but with a funnel-mouthed "deflector" to the inner tube. This is found to be a great aid to the circulation. The two outer circles of water-tubes are made longer than the rest, and are arranged to form the fire-box walls. The other and shorter tubes are bent inward, or converge to a point

below the central flue, so as to deflect the heat and products of combustion among the other tubes; and, in order to further secure this, a hollow baffle-plate is placed immediately below the chimney. Through this baffle the exhaust steam passes.

The boilers now used by William Roberts, of Millwall, England, and patented in 1863, consist of a cylindrical and vertical case, with tubes passing from end to end. Underneath this boiler is the fire-box, likewise contained in a cylindrical case; and in a circle around and within this case, and at a short distance from the side, are other vertical tubes. These communicate at their upper ends with the water in the boiler, and at their lower ends with a ring tube, into which the feed-water is introduced. The steam is taken for use from a ring tube, to prevent priming when the throttle is suddenly thrown wide open.

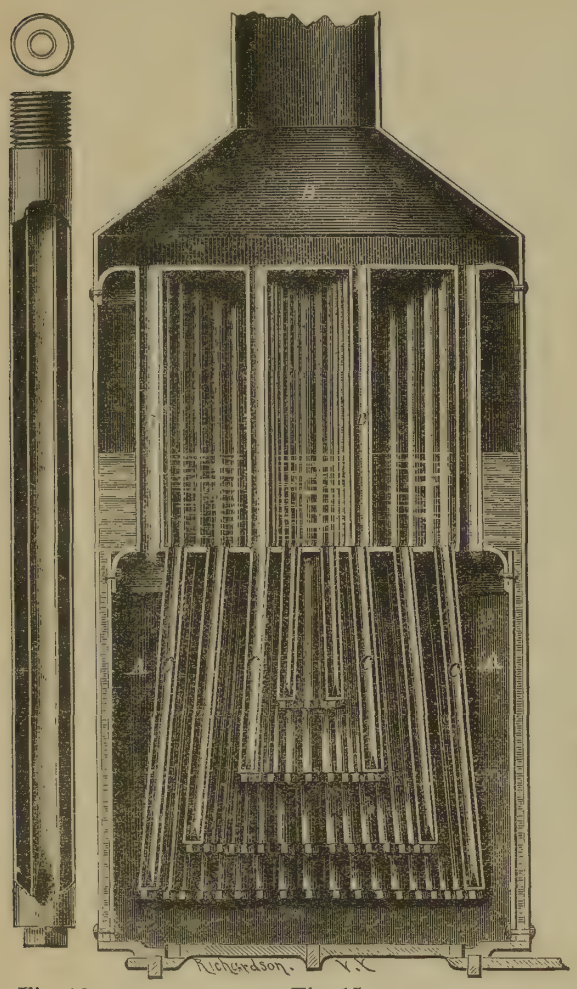


Fig. 16. Fig. 15.

The "Jucket" boiler seems to resemble the "Roberts." It is upright, both tubular and tubulous, being like the Amoskeag, except that the fire-sheet is larger; and from the outer edge of this descend water-tubes, open at both ends, and forming the fire-box walls. The water-leg is slightly tapering on the inside.

The second-class engine has a boiler 64″ high, 32″ diameter, $\frac{3}{16}$″ thick; fire-box 24″ high; grate, 24″ diameter; lower flue-sheet, $\frac{3}{8}$″ thick diameter; upper flue-sheet $\frac{1}{4}$″. There are 165 copper flues, each $1\frac{1}{2}$″ external, $1\frac{3}{8}$″ internal diameter, $14\frac{5}{8}$″ long; and 45 copper water-tubes around the fire-box, each $1\frac{3}{8}$″ external, $1\frac{1}{4}$″ internal diameter, and 24″ long. The submerged smoke-dome is 4″ high. The smoke-passage surrounded by steam is $19\frac{1}{2}$″ high, 14″ diameter. The stack is 14″ diameter. The leg tapers from $\frac{7}{8}$ to $\frac{5}{8}$ inch. There are 3.14 square feet of grate surface.

The cuts given herewith, Figures 15 and 16, show the new form of boilers made by the Silsby Manufacturing Co. It will be noticed that the water-tubes (C) have been shortened, the smoke-flues (D) lengthened, and the grate-surface increased. Figure 16 shows a water-tube detached.

There are many features now used in Steam Fire Engine boilers, that date much further back than is commonly supposed.

The British patent, obtained by Sutton Thomas Wood in 1784, gives the earliest description of a modern tubular boiler with internal fire-box, the author has met with, and has been overlooked by nearly every writer upon boilers.

The first upright steam boiler in which the fire and heated gases ascended through a number of vertical tubes, surrounded by water, into a submerged smoke-box, was patented in England in 1826, by James Neville. This submerged smoke-box was repatented some years since in America, and lately in England, as was also another feature—the plan of taking the boiler apart by loosening some bolts and nuts.

The use of water displacers or annular steam "pockets" to obtain a large water-surface with small bulk of water, was patented by Matthew Pitts in 1793, and again by John McCurdy in 1825.

The principle of a circulating boiler with tubes within tubes, was patented by Jacob Perkins in 1831. Field added a trumpet-mouth or funnel end to the inner tubes. A trumpet-mouthed tube may be seen in the "Mechanic's Magazine" (No. 1671, for August 18, 1855) in the drawing of Barran's cup-surface boiler, where a suspended water-box is shown with trumpet-mouthed tubes leading into the steam space; but does not effect thorough subdivision of the water.

A "forced circulation" boiler, known as Benson's, and used by William Roberts in the first English self-propelling engine, and in which the tubes are in the furnace, and the circulation effected by a force pump, was patented by Moses Poole, of London, in 1829. A similar arrangement was used by P. R. Hodge in 1840-1, in the first Steam Fire Engine built in America. Harrison Dyer, of Boston, used forced circulation in 1830, in his road locomotive. †

ALUMINIUM AND ITS FUTURE IN THE ARTS.

It is now about twenty years since the celebrated French chemist, Deville, succeeded in demonstrating the possibility of producing the metal aluminium upon the large scale; but up to the present, the extent to which this interesting and praiseworthy invention has been utilized, has but to a slight degree realized the sanguine expectations which intelligent minds of all professions have been accustomed to associate with it. So important, indeed, were the fruits of Deville's first investigations deemed to be, that they were at once invested with the dignity of royal patronage, and the first works for the manufacture of the new metal were shortly thereafter erected at Javelle, near Paris, from the private purse of the late Emperor of the French. It was expected that the new product would at once find its way into the useful arts as an effective and valuable substitute for many other metals. That these expectations were well founded, will be apparent from the characteristic and very exceptional properties of the metal. A bright, pure surface of aluminium possesses a greyish white color, something between that of zinc and tin. Its extreme lightness is one of its very distinguishing properties, and affords an immediate means of identifying it from every other metal—its specific gravity is but 2.5 (water=1), from which it appears that it is about three times lighter than copper, four times lighter than silver, and nearly eight times lighter than gold. When struck, it emits a loud, clear, musical tone, which has been compared with that of crystal glass. The keen observing powers of the French chemist did not permit this property to pass unnoticed. He suggested the employment of aluminium for bell-metal, and in the year 1868 presented to the Royal Institution of Great Britain a bell a foot and a-half in diameter, which proved to possess a most exquisite tone, and which, despite its not inconsiderable dimensions, weighed no more than forty-four pounds.

The metal may be hammered out into the thinnest leaves, rolled into plates or sheets, and drawn into the finest wire. Its hardness approaches that of fine silver, and its tensile strength equals that of copper. Its melting point lies at 700° C. (about 1300 Fahr.), or between that of zinc and silver; and it is worthy of note that it fuses with extreme slowness, and does not vaporize even in the heat of the blast furnace. Generally speaking, the metal is workable to an extraordinary degree, and it may be filed, turned, pressed, engraved and coined quite readily. In compact masses the metal is quite indifferent to atmospheric influences, and even when being smelted, it does not sensibly oxidize. It must be remarked, however, that the properties above enumerated are predicated upon the presumption that the metal is free from impurities.

The adaptability of aluminium as a circulating medium to substitute the great variety of small coin of various compositions now employed in the different countries, was strongly urged at the outset by Deville; and as long ago as 1855, a large and beautifully executed medallion of this metal, made under his direction, and presented to Prof. Wöhler, its first discoverer, attracted much attention. The properties of aluminium, which have been appealed to as establishing its admirable fitness for coinage into money, are, in addition to its color, klang and ease of manipulation, its extreme lightness, which would serve as a perfect check upon its fraudulent imitation, and especially its indifference to atmospheric influences. In this latter respect it is far superior to silver and copper, and the alloys of these metals, at present so largely employed for this purpose. Weights of aluminium, for example, have for a number of years been employed, and have proved to be excellently adapted for the most delicate work of precision in the laboratory, retaining their accuracy even after years of use. The same admirable conservation has been remarked upon the numerous articles of luxury and fancy, which, immediately after the first public knowledge of the metal, it became the fashion to possess. Nor can it be urged with much reason that it is undesirable for coinage purposes because of the possibility of the discovery in the near future of some simple method of producing the metal from clay—which is known to contain it in considerable proportion—since this problem has been repeatedly attacked and as often abandoned as hopeless of solution; and the price of the metal has remained very constant for a number of years.

It may be considered an objection to its employment for monetary purposes, that it is energetically dissolved by a solution of soda or potash; but in reply, it may be remarked that silver and copper are equally objectionable in this particular, since they are both eagerly dissolved by nitric acid, to the action of which aluminium is quite indifferent. Upon the whole, it appears to the writer that the permanency of the metal, by which is meant its great stability when exposed to atmospheric influences, and its indifference to the action of many of the usual solvent agents, and the great difficulty attending its production in large quantities, fairly entitle aluminium to be ranked with the noble metals; and when, in addition to the foregoing, its very exceptional properties are called to mind, the metal may justly claim careful consideration on the part of those who interest themselves with the question of reforming the world's circulating medium.

In the manufacture of jewelry and other articles of luxury, it is probable that aluminium may in time play an important part, though it is scarcely possible for it to ever rival the popularity of silver in these uses. In Paris, which by the way has always remained the head-quarters of the aluminium industry, it appears to be employed to a considerable extent for elegant inlaid work upon jewel and dressing-cases, fans, &c., for lids and covers of glasses, and for a variety of small articles of *galanterie*. From what has been done in this direction, we can estimate its fitness for a thousand elegant articles of taste, fancy and utility, when once its popularity is established before the world at large, which is now scarcely cognizant of the existence of such a metal as aluminium. The clock and watch-makers' art, the manufacturers of surgical and musical instruments, and of artificial teeth, and especially the manufacturers of fancy articles, such as seals, pen-holders, paper-weights, smokers' and sportsmen's necessaries, shirt and sleeve buttons, canes and riding-whips, harness decorations, statuettes, gas-fixtures and lamps, and of other articles too numerous to mention, would without doubt derive much advantage and profit from the employment of aluminium, and sooner or later its peculiar fitness for these uses will be recognized.

For the manufacture of philosophical and engineering instruments, and especially the latter, the indifference of aluminium to atmospheric influences, and its extreme lightness, have of late met with general recognition, and the employment of the metal for these uses is steadily growing in favor.

For household utensils, likewise, aluminium has been highly recommended; but though, for this purpose as for others, neither its want of desirable properties nor excessive costliness have stood in the way of its introduction, it has been opposed by the despotic rule of custom or fashion, and in no instance with less show of reason. How much, for example, has been written and spoken concerning the danger of poisoning from the vessels employed in preparing food? How many warnings have been uttered against using copper cooking utensils, pots with lead glazing, and silver spoons that form verdigris? Were these household goods made of aluminium, we should be in possession of vessels, that, so far as outward appearance and durability go, leave very little to be desired; that, furthermore, would be far more convenient to handle than the customary wares they would replace; and, what is of perhaps more importance, that would be perfectly innocuous. It appears somewhat curious that the experiment has never been tried of introducing the use of aluminium spoons. The present or prospective cost of aluminium can scarcely be offered as an objection thereto, for this is now only about one-half that of silver; while the difference in the specific gravity of the two metals is so considerable, that for the money value of one silver spoon of good quality, one might obtain no less than seven spoons of aluminium, of equal size and strength.

That prejudice and fashion are to some extent to blame for the general want of

appreciation (and even of total ignorance) of the eminently fitting characteristics of the new metal for a variety of uses, is very manifest; and the clearing away of such obstacles is generally a matter of great difficulty.

The alloys of aluminium are, however, worthy of special consideration, and there is a reasonable probability that a wide field of utility may be open for them in the future. Dr. Biedermann, referring to this subject, remarks, "although there is no mistaking the fact that the high expectations, with which the appearance of aluminium filled the public mind, have not been fulfilled, yet the aluminium industry has a safe guarantee of its existence in the use of the metal for aluminium alloys, which are capable of the most extensive use on account of their excellent qualities." The only aluminium alloys which have, however, acquired importance in the arts, are the so-called aluminium bronzes.

According to M. Morin, the director of the manufactory of Nanterre, very homogeneous alloys are obtained with copper and 5, 7½ and 10 per cent. of aluminium. The alloys with 5 and 10 per cent. of aluminium are both of a golden color, whilst that with 7½ per cent. has a greenish tint. Even so small an addition as 1 per cent. of aluminium to copper, according to another authority, considerably increases its ductility and fusibility, and imparts to it the property of completely filling the mould, making a dense casting free from air-bubbles. At the same time the copper becomes more resistant of chemical reagents, increases in hardness without losing in malleability, and unites in itself the most valuable qualities of bronze and brass. A copper alloy with 2 per cent. of aluminium is said to be used in the studio of Christofle, in Paris, for works of art. It works well under the chisel and graver.

The true aluminium bronzes, according to Rudolph Wagner, were first made by John Percy, in 1856. As above referred to, they are alloys containing 90 to 95 per cent. of copper with 10 to 5 per cent. of aluminium. The direct mixture, by first fusion, of 10 parts of aluminium and 90 of copper, gives a brittle alloy, which, however, increases in strength and tenacity by several successive fusions. At each operation a little aluminium is lost. After the compound has been melted three or four times, however, the proportion of aluminium does not appear to change, and the alloy may be again remelted several times without alteration. These fusions are effected in crucibles. The aluminium bronze is homogeneous, and possesses sufficient expansion to fill the remotest parts of the mould. It affords sharp castings that can be worked more readily than steel. Aluminium bronze may be forged at a dull-red heat, and hammered until cooled off without presenting any flaws or cracks. Like copper, it is rendered milder and more ductile by being plunged into cold water when hot. The bronze polishes beautifully, and possesses great strength —according to Anderson's experiments, an average of 75,618½ lbs. per square inch. The resistance to compression is feeble. From the experiments of Col. Strange, on the relative rigidity of brass, ordinary and aluminium bronze, it appears that the last named is 40 times as rigid as brass, and 3 times as rigid as ordinary bronze.

Other experiments have shown that aluminium bronze does not expand or contract as much as ordinary bronze, or brass; that under the tool it produces long and resisting chips, does not clog the file, engraves nicely, etc.; that it is easily rolled into sheets; that in the melted state it expands very much, and is fit for the sharpest castings; but that, as it cools off rapidly, it is subject to shrinkage, and hence to cracks when the articles are bulky, hence requiring numerous runners and a heavy feeding head; and lastly, that, although not entirely unoxidizable, it is not so readily tarnished by contact with the air as polished brass, iron, steel, etc. Dr. Biedermann speaks very highly of this metal. "In the construction of physical, geodic and astronomical instruments," he says, "it is far preferable to all other metals. In jewelry and articles of art and luxury it is employed in large quantities. Many kinds of house utensils are made of it, and it is also adapted to journal and axle boxes. Gun and pistol barrels, as well as rifled cannon, have been made of it, and have done excellent service." It has been highly recommended for type metal; type made of it lasting, it is affirmed, fully 50 times as long as those from common type metal; it has been employed for the bed of perforating machines for perforating postage stamps; and for the mainsprings of watches (90 copper and 5 aluminium), being very hard and elastic, not magnetic, and less liable to rust than steel. Its price, however, ranging as it does from $3 to $10 per lb., according to its percentage of aluminium, is probably the greatest impediment to its common use.

Aluminium alloys with many other metals have been made—notably with silver and iron—but none of them have acquired a permanent value in the arts. They may be passed over with the brief remark that aluminium containing 4 per cent. of silver is employed for the beams of fine balances—for which it is peculiarly fitted from its comparative lightness and stability; and that the addition of a small percentage of aluminium to steel is claimed to impart special virtues to the latter—a claim which, however, has not yet been well established.

In another direction, namely, in electro-plating and coating other metals with aluminium, numerous experiments have been tried, but thus far without practical result.

A few words more concerning the process of manufacture and the present commercial importance of the metal, and we have done. Its metallurgical production is as follows:

Aluminium is manufactured by decomposing the double chloride of aluminium and sodium, with the aid of metallic sodium. The sodium (which, by the way, has been materially cheapened in price since the establishment of the aluminium industry) is obtained by heating to redness a mixture of one hundred parts of calcined soda, fifteen parts of chalk, and forty-five parts of coal. The chloride of aluminium is prepared by passing chlorine gas over a moderately heated mixture of pure alumina (obtained either from alum, or the mineral bauxite), common salt and coal-tar. This operation is conducted in an iron gas-retort, and the result of the interaction of the several substances present is the combination of the coal-tar with the oxygen of the alumina, and the production of aluminium chloride, which unites with the chloride of sodium (common salt), forming a double salt, which volatilizes and is passed off into a separate chamber, where it condenses. From this method of obtaining the chloride, it is impossible to keep it free from chloride of iron, for which reason the Parisian aluminium is invariably impurified therewith. From this double chloride of aluminium and sodium, the metallic aluminium, is obtained, either by passing it in the form of vapor over a heated surface of metallic sodium, in a simply constructed and connected system of iron cylinders appropriately heated; or the materials are at once mixed and heated.

Rose, of Berlin, instead of the artificially prepared aluminium chloride, employed the mineral kryolite (a natural compound occurring in deposits of considerable magnitude in Greenland, and consisting of fluoride of aluminium and sodium) quite successfully. By heating this mineral with sodium, metallic aluminium and fluoride of sodium are produced, and the latter compound is gotten rid of by treating the resulting mass with caustic lime. Of late the metal has also been manufactured from the mineral bauxite.

At present there are four aluminium works in existence, of which three are in France and one in England. Their total production amounts to about three thousand five hundred pounds yearly, of which two thousand pounds are produced in France, and one thousand five hundred in England. Its market value has averaged about fifteen dollars per pound, and has been for some years stationary at that figure. *

THE BARS OF THE MISSISSIPPI.

The bars in the Mississippi are chiefly composed of movable sand, and travel down stream at a rate in proportion to the velocity of the current, changing their shape as they pass the bends of the river or meet with obstructions that lessen the velocity, or deflect the current from its natural direction. These bars so overlap each other that a longitudinal section of the river bed would show inequalities similar to the surface of a shingle roof, as shown by the full lines in Fig. 1.

The dotted lines show the changes constantly taking place in the surface of the bars. The material from *a a a* is deposited in the dead angle *b b b*, the bars preserving substantially their shape, but travelling down stream. A plan of sand bars upon a perfectly straight river-reach, which presents a cross section approximating the trapezoidal form, the crest of the bar being the highest about midway between banks, is shown in Fig. 2.

Fig. 1.

Fig. 2.

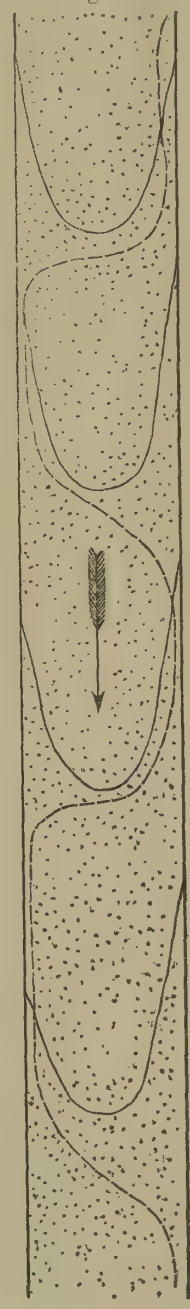
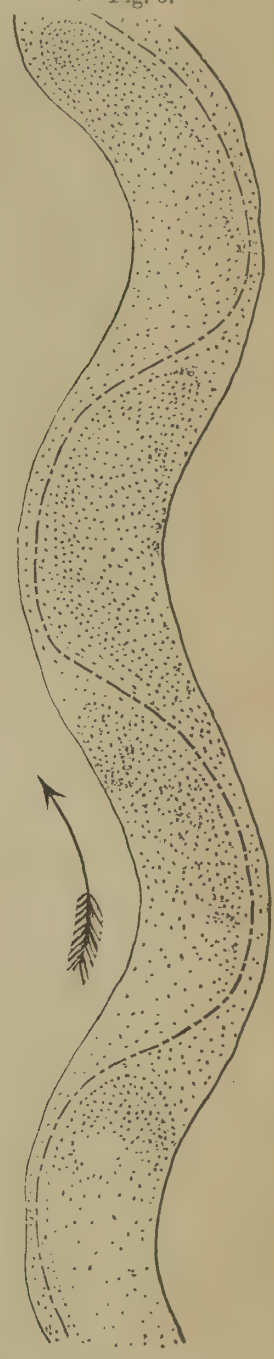


Fig. 3.



Of course we do not find this regularity in all parts of the river. In fact, if it were possible to make the river perfectly straight, it would not long remain so unless its banks were protected from erosion. We usually find reaches, which are straight in general direction, broken up into very short curves, and approaching the form presented at well-defined curves, as shown in Fig. 3.

The introduction of any foreign substance, such as snags, drift-piles, &c., will change materially the shape and movement of the bars; so, also, will the curves of the banks. When the river rises, the movement of the bars is more rapid, and as the bottom of the river also rises and falls again with the water, a channel is then formed in a new place as the water recedes, the crest of the bar giving way at its lowest point, which is usually nearest the shore, generally leaving a pool of water below each bar, and the low-water channel winding from side to side under the crests of the bars and through the pools.

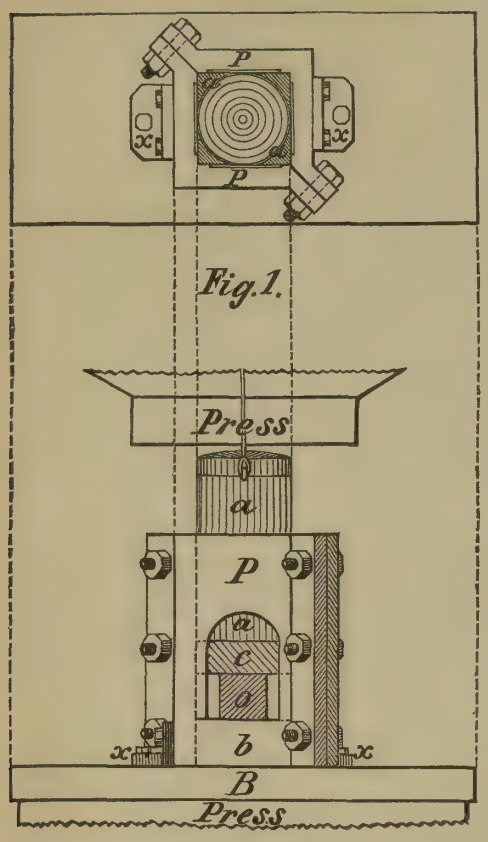
In the case of rivers flowing through alluvium, the channel follows a succession of curves—convex connecting with concave, and that the deepest water generally follows the concave bank. The steamboat crossings are along diagonal lines, running from near the lowest point of one concavity to a point above the apex of the alternate opposite concavity. —[Col. James H. Simpson, Corps of Engineers, U. S. A.]

REPORT ON THE COMPRESSIVE STRENGTH, SPECIFIC GRAVITY, AND RATIO OF ABSORPTION OF THE BUILDING-STONES OF THE UNITED STATES IN MOST GENERAL USE.

BY LIEUT.-COL. Q. A. GILLMORE, CORPS OF ENGINEERS.

[*Abstracts and Abridgment.*]

The accompanying cut (Fig. 1) shows the instrument used to give security to the direction of the pressures. *P* is a cast-iron frame, 1″ thick; *B*, a 1½″ cast-iron plate, to which it is fastened by lugs *x x*; *a a* cast-iron mandrel with steel plate, *c*, 1½″ thick, secured to mandrel by 1½″ steel screw, wrought on back of plate; *b*, steel disk, 2″ thick, set into same guides into which the mandrel works. The mandrel and disk have 4″×4″ square faces, exactly parallel to each other, and perpendicular guides. All the steel was hardened to straw-color, and then worked true. The mandrel is secured to the top beam of the press by wire cordage, the weight of the frame bringing that down easily after each breakage. The object, *o*, is placed truly under the centre of the mandrel, through one of the four arched apertures in the frame, and the frame raised again by the pump, the stone being broken between the steel face *c* of the mandrel, and the steel disk *b*.



The top of the mandrel is segmental, so as to create no resistance to the true action of the guides, and a bulk of wood, 4×4×½ inch, is laid upon this segmental top. This became hard and convex, but lasted throughout all the experiments. Fig. 2 shows the phenomena of "flowage," causing the stone blocks to break sooner under the lead or leather than under stone or wood. There were therefore obtained a granite similar to the lining of the Albany capitol, and a marble similar to the Vermont, both of which were well known from prior experiments; were solid and fine-grained, taking an excellent surface, but were both, of their kind (and certainly as compared with Millstone Point granite and East Chester marble), friable, as might be observed by attrition with the thumb-nail; and they evidently possessed less tensile, and, therefore, less beam strength, than the average rocks of their kind. The granite, though well-knit, was micaceous in small spangles, the other granular, like white sugar. These were tested exactly like the others, except that some of them, which cracked before breakage, were excluded from the record.

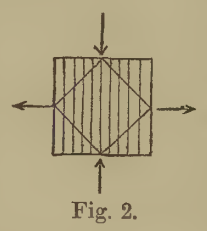


Fig. 2.

TABLE III.—A.

KIND OF STONE.	STEEL.	WOOD.	LEAD.	LEATHER.
LIMESTONE (Chalk), Sebastopol, mean of 14 cubes, 2×2×2 in., all breaking at nearly same	4,300	4,300	4,300	4,300
Percentage	100	100	100	100
SANDSTONE, drab, 3 cubes, 1½ in. in all	9,000	9,000	9,000	
Percentage	100	100	100	
SANDSTONE, from Massillon, Ohio, 2 in. cubes	37,000	37,000	29,000	
	31,000	33,000	.....	
	34,000	35,000	29,000	
Percentage	100	103	85	
Another and softer Sandstone, from Massillon, Ohio, 2 in. cubes	29,800	28,444	17,800	13,000
	*17,600	29,800	23,400	14,600
	22,600	26,766	25,080	14.600
	21,000	22,600	21,720	16,000
Average	22,640	26,901	22,000	14,550
Percentage	100	118.8	97	64
* Omitting this result, and the percentage becomes	100	110	90	59.4
SEBASTOPOL LIMESTONE, in slabs 2×2×1 inch	4,700	4,900	5,000	4,500
	4,500	4,500	4,700	5,000
Average	4,600	4,700	4,850	4,750
Percentage (probable)	100	100	100	100

The result of these tests shows a divergence instead of a convergence in relative results; and as the last named or softer granite gave, under steel (where its compressive strength may be supposed to be tested), the same results as the first, it became suggestive that it was not softness alone which had quantitatively changed the results between the two under the rigid steel and the spreading wood. It was well, however, to test this by other experiments. There happened to be on hand soft Sevastopol limestone or chalk, from the ruins of the Malakoff, and which was at least soft enough to suit the purpose. There were also on hand three 1½ inch cubes of a soft drab sandstone, and two sandstones from Massillon, Ohio. The first, or the chalk, crushes at about 1000 lbs. per square inch, the drab sandstone at about 4000, and the Massillon sandstone at from 6000 to 8000. Now, if the softest of these stones gave the same results under steel, wood, lead and leather, there could be little doubt that, so far as softness was concerned, the results would not be divergent.

A glance at Table III—A, will show that this is the case both with the chalk crushing at 1000 lbs., and the drab sandstone at 4000; the former giving a uniform percentage of 100 for steel, wood, lead and leather, and the latter the same for steel, wood and lead, the leather test having been omitted.

[*To be Continued.*]

A NEW STEAM STREET CAR.

The cut shows the Steam Street Car built by the Baldwin Locomotive Works, Philadelphia, and in successful operation for the past three months on the Atlantic Avenue line, Brooklyn.

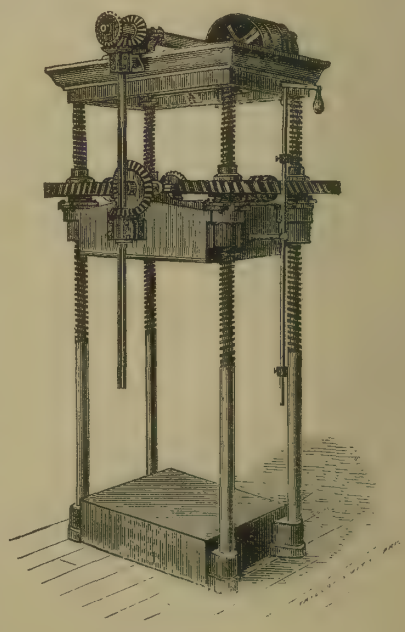
There are two 6×10 cylinders attached to an inverted cast-iron bed-plate, bolted to the car bottom near the centre-line and in front of the rear axle. The cranks are on the front axle, which has both inside and outside bearings. The jaws for the inside bearings are cast on this bed-plate. The valve-gear is the usual shifting link. The exhaust is carried through a system of pipes, so that it is partly condensed before escaping, and is nearly noiseless. The boiler is vertical, 72×30″ and of ¼″ steel, with tubes 48×1½″, and fire-box 22″ high, and is placed on the front platform, one-half being let into the car front; is neatly cased so as not to be visible from inside. It is covered with 1″ of felt, ½″ of pine, and ½″ of walnut. The car is of the usual pattern, with 16 feet body; has four 30″ wheels, only one pair driven by the engines. Steam-brakes stop it in half its length.

Running alone, the car takes 8 lbs. of anthracite per mile run. Two additional cars have been drawn on the Atlantic Avenue line, and an additional car is taken on certain trips when the greatest number of passengers offers.

The city authorities have permitted the use of these steam cars on the line named. It is to be hoped that the present generation of wretched horse cars will soon be superseded by the cheaper, quicker and surer steam car.

IMPROVED QUADRUPLE SCREW-PRESS.

The cut represents an improved quadruple screw-press made by Mr. James Eccles, of Philadelphia, which is designed to afford a more uniform pressure distributed over the surface of the platen for the compressing of materials required to be condensed in bulk or pressed to an even surface, than is possible with the ordinary two-column screw-press as usually employed. It is obvious with the ordinary press, the pressure being applied at the central line of the platen, the outside edges farthest removed from the point where the pressure is applied can only receive such pressure as the rigidity of the material composing the platen and screws can convey without deflection. The improved quadruple press is designed to overcome this defect, and its superiority in this regard will be apparent by a glance at its construction. This improved press, as its name implies, has four screw columns, with four worm-wheels attached to the upper platen—the hub of each forming a nut engaging with the screw columns. Each pair of the worm-wheels is driven by a worm, securely attached to a horizontal shaft; each worm, of which there are two, being arranged to gear into and drive a pair of the worm-wheels at the same time. Another recent improvement consists in a novel mode of applying the belt power. Heretofore the belt pulley was carried by the upper platen, thereby constantly varying the position and effective power of the belt. The driving apparatus is now placed on the top of press, but may be attached to the base-plate, and is driven by a single belt; and further, consists in one loose and two fast pulleys, connected by shafts and bevel gearing to the upright shaft at the back of press, on which is placed a bevel pinion provided with a feather key, and which, of course, ascends or descends with the upper platen. This pinion gives motion to the horizontal shaft, worms and worm-wheels above named. An automatic stop-motion is also applied, which can be set at any desired point. The pressure applied may be judged from the fact that a 4½″ belt travels 7,800 feet for one foot movement of press. This press seems to be eminently adapted to secure a great and uniform pressure. It was one of the first machines placed in Machinery Hall for exhibition at our coming Centennial. Letters patent for above improvements are now pending.



THE BISMUTH LODE, NEAR BEAVER, UTAH TERRITORY.

[*Editorial Correspondence.*]

The following statements from the contents of a letter received by the Editors from a thoroughly trustworthy and highly esteemed correspondent, who writes from Salt Lake City, will be found of interest. The subject is the occurrence of a bismuth lode in the neighborhood of Beaver City, Utah Territory, which our correspondent affirms to be unique and noteworthy.

"The bismuth lode embraces two locations, or claims, each 1200 feet in length, and abutting against each other. One of them is known as the 'Starr King,' and the other as the 'San Francisco,' bismuth mine. It is a definite and unmistakable fissure vein, cutting through a white, calcareous sandstone overlying granite. The mountain-ridge called 'West Mountain' is composed entirely of granite, and the mining district in which this bismuth mine is situated is named therefrom, 'Granite Mining District.'

"The San Francisco and Starr King mines are located on one continuous and uninterrupted vein, cropping out hundreds of feet in length at intervals, and traceable on the surface. There are three veins of this ore, parallel with each other, definite and clearly visible, and projecting above the surface of the ground, and all three embraced within a width of 50 feet. They probably unite in depth, and I therefore recognize them as only one lode in fact, and as all three are embraced within the area of width allowed for location by the U. S. Mining Law of May 10, 1872, they are included in the same name. But the width of these veins varies. The widest stretches highest along the ridges upon which they outcrop. This is full six feet wide. The next below (all, indeed, are about on the same level), or toward the valley, is about two feet wide, and the third is about one foot in thickness.

"All are of the same character, carrying garnets, and impregnated with bismuth sulphides and oxides. The veins are as definite, with hanging and foot-walls, as the black lines on this paper (referring to letter). The wide vein has been opened with a shaft 70 feet deep, and a tunnel of 35 feet at some 600 feet from the shaft. Besides this, prospect openings have been made, showing the continuity of the lode, at the opposite ends of the locations. The narrower veins have also been opened sufficiently to show the uniformity in character of all three of these fissure deposits.

"The metallic product of the whole lode will probably average from 3 to 5 per cent.; selected ores will carry as high as 15 to 20 per cent. of metallic bismuth. The ore has been concentrated to 40 per cent. in 'Krom's Dry Concentrator,' and Mr. Nichols, Krom's agent here, has certified in writing, that in large quantities it can be concentrated up to 60 per cent., or higher. Three per cent. ore concentrated by Krom's dry process, yielded 34½ per cent. of metal by fire assay, in the hands of Mr. Frank Foote, assayer, of this city; some six per cent. more, he thought, was lost by the imperfection of his method.

"These claims are so situated that they can be developed with advantage by drifting directly into the vein from the gullies which cut the lead at two or three points, or by tunneling into the face of the opens, or by shafts and levels run at different depths.

"The situation of the mine is eleven miles west of the town of Beaver, a place of some 4,000 inhabitants, and the seat of the First Judicial District of this Territory. It is about 225 miles south of this city. The Utah Southern Railroad is now built 75 miles southward, and is to be extended 150 miles further south this coming summer, and will pass quite near the mine in question. The position of the mine is therefore quite eligible for working. The mountain country, for miles around, is studded with the mountain cedar and pines, and water in sufficient quantity for all purposes requisite for driving machinery, &c., exists in the shape of an unfailing and ample spring. High up the mountain-side more water is found, which could be conducted, if required, to any part of the mine." *

INFUSORIAL EARTH AND ITS USES.

I.

Geologists have long since established, beyond peradventure, the fact that there are rocks in the interior of continents, at various depths in the earth, and at great heights above the sea, which are almost entirely made up of the remains of what were once living organisms. Such rock-masses, says Lyell, may be compared with modern oyster-beds and coral-reefs, and like them, their rate of increase must have been extremely gradual. But there are a variety of mineral deposits that are now proved to have been derived from plants and animals, of which the organic origin was not suspected even by naturalists. Great surprise was therefore manifested when Prof. Ehrenberg, of Berlin, announced the discovery that a certain kind of siliceous stone, called tripoli, was entirely composed of the remains of countless millions of extremely minute organic beings. This observation of the famous German microscopist speedily led to the discovery of the fact that deposits of this character were quite abundant, and that they were even being formed at the present time over extended areas. The minute organisms, whose skeletons make up the bulk of the deposits which are now known under the name of infusorial earth, have been shown to inhabit the ocean in inconceivable numbers, giving rise to the luminosity of the waters, which has been the subject of much discussion, and flourishing in almost every place where water stands for several months of the year. Their indestructible shells are therefore to be found in greater or less quantity in the sedimentary deposits of all our bogs, ponds and slow streams. They are found in great abundance beneath peat-bogs, where they constitute strata, often many feet in thickness and of great extent, almost entirely composed of the siliceous carapaces of organic beings, so inconceivably minute that millions of their remains are found in a single inch. Ehrenberg estimates that about eighteen thousand cubic feet of these siliceous organisms accumulate annually in the harbor of Wismar, in the Baltic. He has furthermore demonstrated that they accumulate in the beds of American and other seas, lakes and rivers.

The deep sea soundings which have lately been conducted in various quarters of the world, and have attracted much popular interest, have shown, likewise, that the impalpable mud or ooze which is accumulating at great depth in the bed of the Atlantic and other oceans, is made up almost entirely of the mineral skeletons of certain extremely minute organisms. Of these shells, some are calcareous, and appear to be identical with the organisms which abound in the chalk of Europe—(the chalk, indeed, is largely made up of such organic remains)—while others are siliceous. One of these deposits in the North Atlantic has been traced over a distance of thirteen hundred miles in breadth, and not less than six hundred miles in length.

In peat-bogs, swamps, and the like, both of modern and ancient origin, there are often found layers, at times many feet in thickness, and of considerable extent, of a white siliceous paste, which is found beneath the microscope to be made up wholly of the remains of these minute organisms. These deposits, with which this article is chiefly concerned, are designated by geologists with the name of infusorial earth. The substance of which they are composed, has generally, when dry, the appearance and consistence of friable chalk, and the remains of which it is made up, and which were formerly referred to microscopic infusoria, are now generally held to be plants, called by naturalists, *diatomaceæ*. The remains of these diatomaceæ are of pure silex, and their shapes as seen beneath the microscope are various, and form objects often of extreme beauty. These forms are very marked and constant in particular genera and species, of which many hundreds have been described and classified by Ehrenberg, Bailey and others, and while many of the fossil forms are identical with living species, others are allied to them; and the so-called infusorial beds are sometimes of marine and sometimes of fresh water origin. The infusorial earth may readily be distinguished from the several calcareous and clayey deposits which it resembles in appearance, by the factthat it does not effervesce in acids, and its ready solubility in solution of caustic soda or potash. It has long been well known in the arts as a powder for polishing stones and metals. At Bilin, in Bohemia, which is famous for its occurrence, there is a single stratum of this material, not less in some places than eighteen feet in thickness, and extending over a large area. This stone, when seen beneath the microscope, is found to consist of the siliceous plates or frustules of the above-mentioned diatomaceæ, united together without visible cement, and so inconceivably minute are the particles of which it is composed, that according to Ehrenberg's statement, a single cubic inch, which weighs about two hundred and twenty grains, contains about forty-one thousand millions of individuals, and a single grain no less than one hundred and eighty-seven millions. Other deposits of infusorial earth (kieselguhr) scarcely less extensive occur in Germany, at Berlin, and at Planitz, in Saxony. It is found near Lüneburg, in a stratum nearly twenty-eight feet in thickness, and again at Kliecken near Dessau, and in the vicinity of Cassel. In England, deposits of considerable magnitude have been found in Surry, at the base of the chalk hills, and elsewhere. In Ireland there is a celebrated stratum on the banks of the River Bann, in the county of Down, and which from being in much request for polishing plate, is locally known as Lord Roden's plate powder; another bed is found at the base of the Mourne Mountains in the same county. In Lapland a similar earth is met with, which in times of scarcity, it is said, is mixed by the inhabitants with the ground bark of trees, and used for food. The edible earth of Lillhaggsjon, in Sweden, is of the same nature. The infusorial earth is found in quantity in the Isle of France, and at San Fiora, in Tuscany, and deposits of various thicknesses have been detected in Africa (the tripoli of commerce is an infusorial earth that has long been exported from the country whose name it bears), Asia, Australia and New Zealand. In America it has been found in a great number of localities, and occasionally in enormous quantities. Of this nature are the beds of white earth along the banks of the Amazon, in Brazil, and used occasionally as food (?) by the native inhabitants. They have been detected also in Newfoundland and Labrador. In the United States perhaps the most remarkable deposit is that upon which the City of Richmond, Va., is built: this deposit is, in places, over twenty feet in thickness, and has been traced by Prof. W. B. Rogers, who was the first to point out its nature, from Herring's Bay on the Chesapeake, Md., to Petersburg, Va., and beyond. At Petersburg the stratum is thirty feet in thickness. Beds of the same character and of some magnitude have likewise been found in California, Oregon, and other points on the Pacific, and at West Point, N. Y.; while of less importance are the infusorial beds at Wrentham and Andover, Mass., Smithfield, R. I., Stratford, Conn., and other localities too numerous to mention.

An interesting occurrence of this nature is the deposit of infusorial earth at Drakeville, Morris County, New Jersey, and which through the instrumentality of the writer and others, was first brought into general public notice about three years ago. The bed in question is on the property of the late Frederick S. Cook, and is located at the foot of Schooley's Mountain. The annual report of Prof. George H. Cook, State Geologist of New Jersey for 1874, contained a descriptive article in reference thereto, from which we obtain the following statements concerning its probable extent, &c.:

"It has been known as a white earth or marl for a long time, and some years since was dug out and spread upon the soil as a manure; it had also been observed to possess remarkable excellence for scouring silver. The establishment of a manufactory for making nitro-glycerine and giant powder, at McCainsville, near Drakeville, in which infusorial earth imported from Germany was used, led to an examination of this deposit, when it was found to be the same material with that they were bringing from Europe. The deposit occurs in a depression of the surface just at the foot of the mountain (Schooley's). The swale appears to be occupied in its lowest part by a common swamp of low bushes, growing in wet black earth; but by digging in the black earth it is found to be only about a foot thick, and underneath it is the infusorial earth. The extent of the black ground is about five hundred and forty feet in length by two hundred feet in breadth, and one hundred yards northeast is another but much smaller deposit. A trial pit sunk in the middle of the swale showed a thickness of twelve inches of black earth, eight inches of very light infusorial earth, and twelve inches or more of a much denser infusorial earth. The lower part is said to be three feet thick, but I only examined the upper foot of it."

The report continues: "There is little doubt that other deposits will be found in the small ponds and swamps in this gneiss region, and those interested will do well to make search for it in any of the swales where these little swamps occur. It can be easily reached by digging, and when found can be distinguished from any other white earth by its not effervescing with acids as white marl does; by its not becoming plastic when wet as white clay does, and by its dissolving almost entirely in a strong boiling hot solution of washing soda.

The importance of this material will be appreciated when it is stated that the manufacture of *dynamite*, or giant powder, at Drakeville, has reached fifty thousand pounds a month. There are different grades of *dynamite*, but some of it contains twenty-five per cent. of infusorial earth."

An analysis of an averaged dried sample of the Drakeville deposit yielded the writer 47.12 per cent. of soluble silica.

The next issue of the REVIEW will contain a full description of the numerous industrial uses of this material. *

[*To be Continued.*]

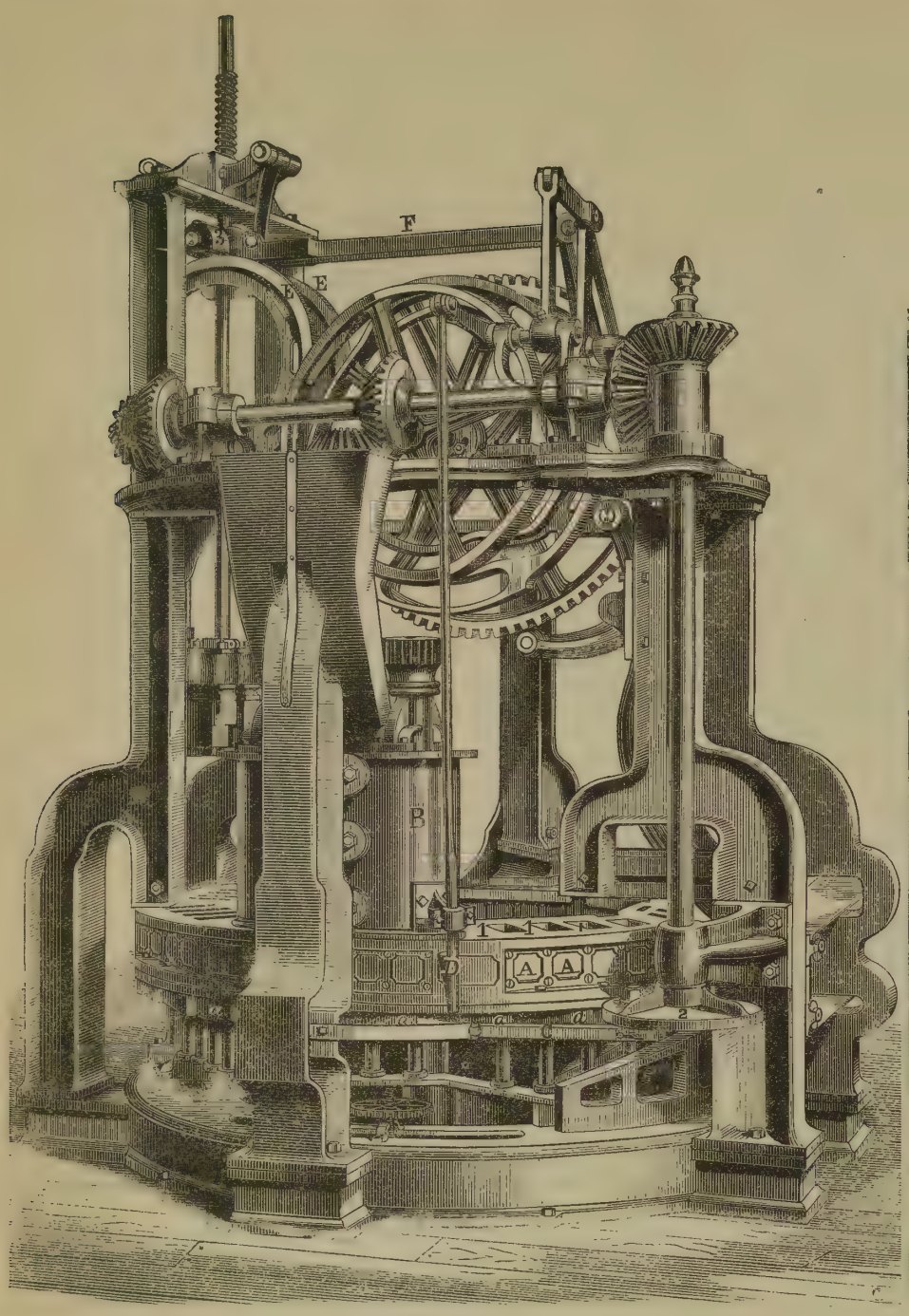


Fig. 1.

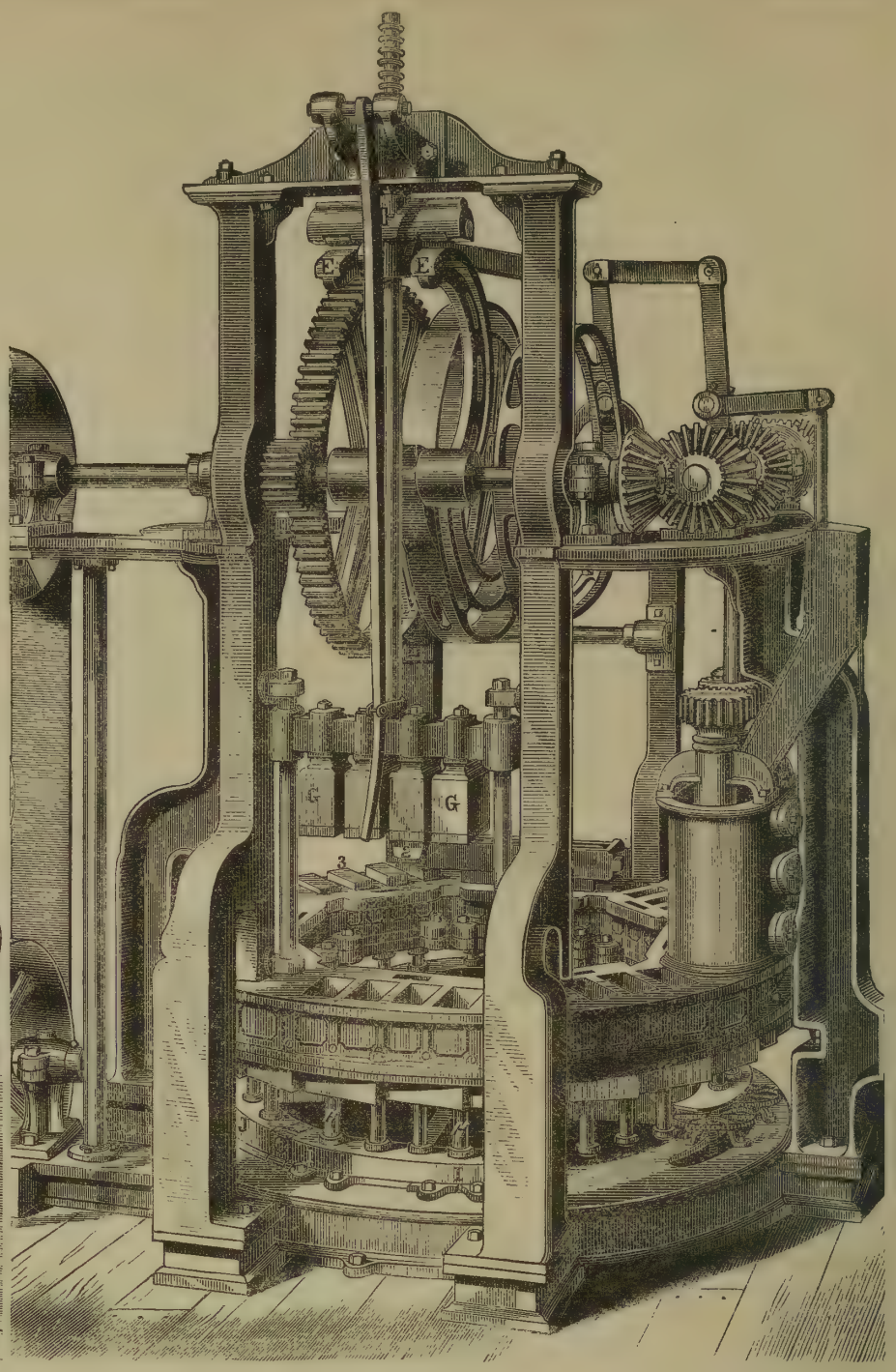


Fig. 2.

GREGG'S "IMPACT" BRICK MACHINE.

The strong prejudice existing among hand brickmakers, against bricks made by steam machinery, will never yield to anything less powerful than the inexorable logic of facts. The numerous failures in the attempts of inventors to produce a good, reliable machine have been a great drawback to much progress in this useful manufacture, for until within a very few years past no machine that has yet been offered to the public has fulfilled the expectations of their inventors or the demands of the occasion. Herewith are given engravings and descriptive matter, showing the construction and operation of a machine at Twenty-eighth Street and and Ridge Avenue, in this city.

Those interested in brick-making are requested to call at the place indicated, to verify, by personal inspection, the statements made in this article.

The principal feature is a rotating mould board (A A) of thirty-two moulds, divided into eight parts or sections, four moulds, firmly bolted together, forming a section. The mould boxes have movable bottoms, to which are fastened, from beneath, followers or stems (H H, Fig. 2). Crude clay, as taken from the bank, without the admixture of water, is broken up between a pair of cone-shaped rollers, the peculiar construction of these rollers casting off the larger stones, and reducing smaller pebbles to grains of silica. The clay reduced in this manner being granulated in form, is now, by means of an elevator of buckets (not shown in the cuts), carried to a hopper (B) when water is admitted and the clay thoroughly tempered. This hopper stands directly over a set of four moulds (1 1). The clay, by its gravity, aided by three spiral "agitators," descends and fills them; when filled, the mould board or carriage (A A) rotates, bringing the four charged moulds immediately beneath four stamps or beaters (G G, Fig. 2), fitting the mould boxes with precision. These stamps or beaters, which weigh 125 lbs. each, are elevated a distance of twenty inches, and, falling independently by one, two or three successive blows, impact or pound the clay within each mould into a solid and compact brick. The four descending stamps being separated, the power is communicated to each brick alike. There is no jar to the machinery while this pounding process is going on, because the followers or stems (H H) alluded to, passing directly through the boxes, are made to stand upon an anvil (I, Fig. 2) prepared for the purpose, so that the blows are *isolated* as it were from the body of the machine. While the stamps are in motion, giving one, two or three blows, another set of moulds is receiving clay, and after leaving the stamps, the mould board (A A) moves round, and the stems or followers begin to ascend a circular inclined plane (J, Fig. 2), gradually pushing out the bricks to a required distance and bringing them under a sizing knife (K, Fig. 3) which cuts off the superfluous or extra clay which was allowed in excess in the moulds, and by this means reduces every one to a uniform thickness. After leaving this knife (K), the followers then continue to ascend the incline (J) pushing out the finished bricks, which finally arrive at the summit or level (L, Fig. 4), where they are swept off by an automatic arm (M, Fig. 4) on to trays, or on to a travelling belt (P, Fig. 4), and are carried away. During the ascent of the incline, the followers receive successively a momentary but powerful upward thrust, *re*-pressing the impacted bricks. The superfluous clay from the stamping, as well as that which is cut off by the sizing knife, is elevated by an endless belt and buckets (not shown in the cuts), and discharged into the pit.

Since the accompanying illustrations were prepared, important modifications have been made, considerably increasing the efficiency and durability of the machine. The arm and sweep (M, N) are now operated by a horizontal rock-shaft, which is actuated by a cam on the vertical shaft shown to the left in Fig. 2. The driving-belts are now placed overhead. There has been some change in the mechanism for rotating and stopping the mould board, making it positive that the moulds shall be directly under the stamps during the impact.

Fifteen horse power will drive the machine, grind the clay, and move the bricks off the machine.

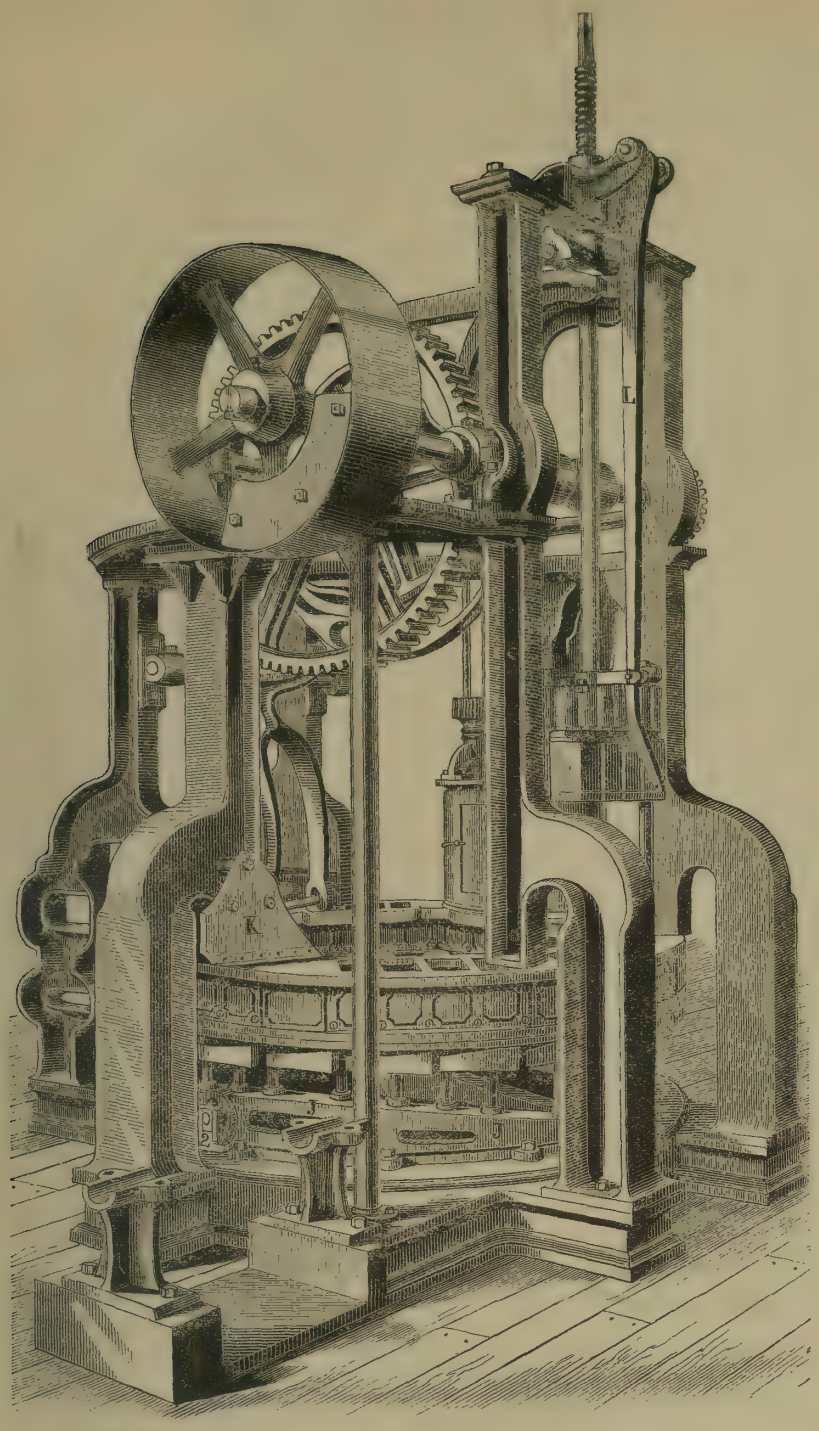


Fig. 3.

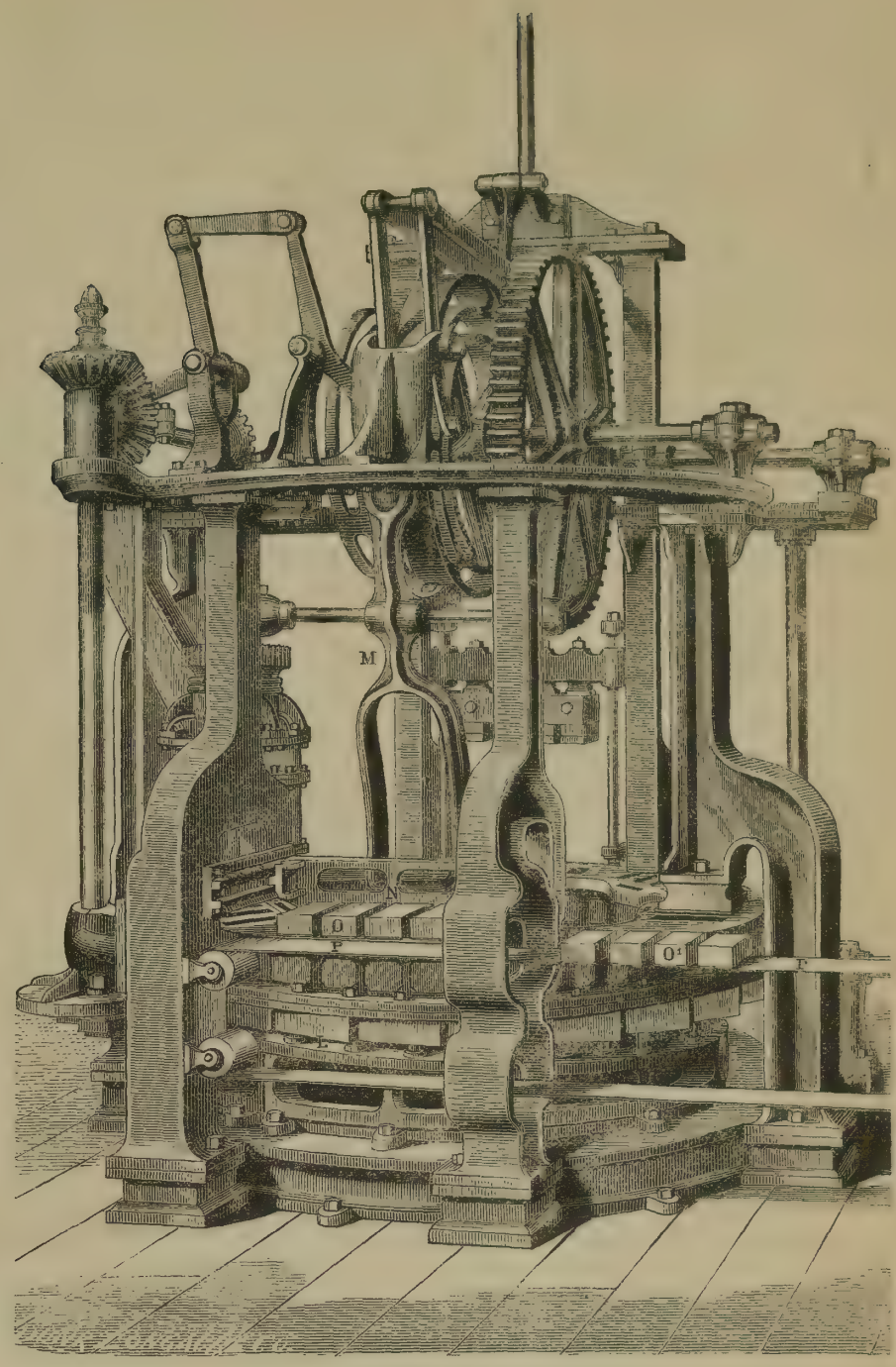


Fig. 4.

The whole manufacture is simply in five operations, viz.: receiving clay at the hopper, stamping it, cutting off the excess, re-pressing, and finally the discharge. While the hopper is charging one set of moulds, the rotating mould board remains stationary, and the stamps or beaters are then in operation at another set previously filled; and when the table rotates to bring another section of moulds in place under the stamps, these last, by a suitable contrivance, are held in suspension, and at the proper time descend to perform their work.

The beaters (G G), which are shown all attached to a single vertical bar, have been separated from each other, and each has its own guide-bar. The spiral spring is omitted. The two horn-shaped cams (E E), and the bar (F), are replaced by four quadrantal cams, which allow each beater to descend independently, giving each filled mould equal impacting force. The followers (H H), which received their ultimate vertical re-pressing force by passing successively over a small wheel whose face projected very slightly above the incline (J), now receive this momentary and powerful upward thrust by means of four levers operated by cams, and this *re*-pressing is now effected while the mould board is at rest, the stems receiving the thrust successively.

The Gregg "Impact" Machine Company expresses itself as being confident that the inventor has discovered a principle in compressing clay and forming it into bricks, that must, when its advantages are appreciated, be universally adopted. It is claimed that this machine tempers the clay, stamps it into the moulds, sizes the bricks, and presses them, at an average of about 2,500 bricks per hour, at one-half the cost of hand-made bricks when they are ready to be moved to the kiln; that the quality of bricks made by this process must necessarily be superior to any other, for they are less porous, and will stand more pressure than any other machine-made brick, and that in these respects, hand-made bricks cannot enter into competition with them at all. In burning, the usual proportion of hard bricks is obtained; and, if the color were only satisfactory, the salmon impact brick would answer as well for an outside wall as ordinary light stretchers, while the arch and hard bricks are superior to any made by any steady pressure machine. The bricks are uniform in thickness, the edges regular and straight, and they make a wall which, for beauty and regularity, can be surpassed only by pressed fronts, which can also, by a change of moulds, be made in this machine without re-pressing. It is urged also that all of the work may be done under cover, thereby saving great loss from rain (often reaching 33 per cent.), incident to manufacturing out in the open field. In view of the fact that the bricks from this machine are dried by artificial heat, the manufacture can be conducted to the same advantage in winter as in summer.

The attention of those interested in the manufacture of bricks is especially directed to the fact of this machine being susceptible of producing grades of *front* or *face* bricks.

This machine has worked continuously for three years, in which time it has made about fifteen million bricks, bringing the highest market prices. In certain respects it has the advantage over any steady pressure machine, for the force used to stamp the clay into the mould will so intimately cement the particles, that a very good brick can be made of very poor clay, while one far superior can be made of good clay. A large portion of the bricks made by this machine has been used in the construction of the Centennial Buildings and surrounding structures.

Blood Albumen, for printing purposes, is reported to be in great demand, and high in price. This statement appears difficult of belief, since every abbattoir or large slaughter-house has at command an abundance of the material for the production of this substance; but the heads of such establishments are seldom sufficiently well-informed or enterprising to properly introduce its manufacture. The present would appear to be the proper time to turn attention to this subject.

MARKED ERAS IN TELEGRAPHY.

In the history of telegraphing to which the world to-day owes so much of its advancing civilization, there are to be found, as in the histories of other great inventions, some curious, quaint and instructive landmarks. A rigidly detailed chronicle of these is not attractive enough for our present purpose; we prefer to pick out some of the curious facts and clothe them with such dress as seems just and becoming.

At this Centennial era the first selection we make is noteworthy as a credit to America, long back of the date of Independence. It was in the year 1748 that Dr. Franklin thus jocosely wrote to his friend Collinson: "Chagrined that we have been hitherto able to produce nothing in this way of use to mankind, and the hot weather coming on, when electrical experiments are not so agreeable, it is proposed to put an end to them for this season, somewhat humorously, in a party of pleasure on the banks of the *Skuykil. Spirits*, at the same time, are to be fired by a spark sent from side to side through the river, without any other conductor than the water, an experiment which we some time since performed to the amazement of many. A turkey is to be killed for our dinner by the *electrical shock*, and roasted by the *electrical jack*, before a fire kindled by the electrified bottle; when the healths of all the famous electricians of England, Holland, France and Germany are to be drank in *electrified bumpers*, under a discharge of guns from the *electrical battery*." This "feast" and the *modus operandi* may be found described in Franklin's Works, Vol. I, and in "Vail's American Telegraph."

The English claim that in the preceding year, signals had been transmitted by Dr. Watson across the Thames, through a circuit of two miles wire and two miles earth. Franklin's well-known electrical kite experiment followed close on the one just named, but the whole remainder of the century made little further advance towards practical telegraphing, although it was so brilliantly lighted by the discoveries of Volta, Oersted, Arago and Ampère.

A second landmark is found further on at the end of nearly a third of the present century, when Professor Henry, in 1829, proved that electro-magnets might be charged at great distances, and when, in 1831, Faraday got the first spark from an electro-magnet, and Morse worked out his first idea of the telegraph. It is worth while on this last point to quote Professor Morse's own words from his letter to Hon. Levi Woodbury, Secretary of the Treasury: "In the year 1832," he writes, "on my voyage home from Europe, the electrical experiment of Franklin, upon a wire some four miles in length, was casually recalled to my mind in a conversation with one of the passengers, in which experiment it was ascertained that the electricity travelled through the whole circuit in a time not appreciable, but apparently instantaneous. *It immediately occurred to me that if the presence of electricity could be made visible in any desired part of this circuit, it would not be difficult to construct a system of signs by which intelligence could be instantaneously transmitted.* The thought, thus conceived, took strong hold of my mind, in the leisure which the voyage afforded, and I planned a system of signs and an apparatus to carry it into effect. I cast a species of type, which I had devised for this purpose, the first week after my arrival home."

From about this date experiment and discovery rapidly repeated themselves. If we should closely follow the epitome before us in our English Journal (not too partial to Americans), we should put down the list for the next ten years, thus:

1834—Weber & Gauss established an electro-magnetic telegraph in Göttingen.
1836—Daniell invents his constant battery.
1837—Cooke & Wheatstone bring out the five-needle telegraph.
" Grove invents a nitric acid battery.
" Steinhel introduces earth-plates.
1844—Construction of the first experimental telegraph (Morse) in the United States.
1845—First Telegraph Company (Morse) established.
" [Cooke & Wheatstone patent their single-needle telegraph, in England.]

As regards the organization and progress of this first company, chartered by the State of Maryland, we make some extracts of interest from a rare volume kindly loaned to us by Mrs. B. B. French. They may be profitably compared with the operations (and we were about to say stock manipulations) of our present rich railway companies.

The first meeting for organization was held in the office of the late Mr. B. B. French, then clerk of the House of Representatives, on the 15th of May, 1845; and the proposition being to raise $15,000 to build a line from New York to Philadelphia, strange to say "not a single New York capitalist could be found who would hazard a dollar in the enterprise. Though the subscription list was headed by W. W. Corcoran, of Washington City, with $1000, more than one-half the capital had to be made up by those directly and indirectly interested in the patents, and their family connections." Refused a right to build on any tolerable terms along the railroad and turnpike, the company threaded their way between the two Cities of Washington and Baltimore along the common road.

Their first two *copper* wires, being found deficient in strength, were substituted by iron wires, put up after receiving the long delayed consent of the railroads. The inverted cup was introduced in 1848.

Of the original list of subscribers to their stock, the following amounts headed the list:

Corcoran & Riggs, ...	$1,000,	of Washington.
B. B. French, ...	1,000	"
Eliphalet Case, ...	1,000	"
Charles Munroe, ...	1,000	"
Amos Kendall, ...	500	"
F. O. J. Smith, ...	2,750,	of Maine.

Amos Kendall, as representative of S. F. B. Morse, Alfred Vail and L. D. Gale, and for himself, subscribed for 235 of the whole number of 600 shares of the stock. Mr. Kendall was the first President, and Mr. French the Secretary.

At the beginning of the next year, confidence having begun in the Northern cities, subscriptions came in, and directors were elected resident in Wilmington, Philadelphia and New York. Their receipts for the first year and a-half, were but $4,288.77.

Many interesting points in the early and later history of this company might be selected; we name here only two. In 1848 a committee of the company reported against the possibility of crossing the Hudson by a sub-marine cable, succeeding in crossing on poles near West Point, which was done at Fort Lee. In 1856 a cable was laid with wire covered with gutta percha.

The close of the two volumes to which we have been referring, shows the consolidation of the Magnetic Telegraph Company with the American and House Telegraph Companies, the extension of the lines South and West, and the total receipts for the quarter ending September, 1859, $139,306.34.

DETERMINATION OF LONGITUDES.

One of the very earliest practical applications of the wire-currents was the additional means thus furnished for measuring the arc of a parallel, and the difference of longitude between telegraph stations. The very first work of this nature ever carried out was on the night of October 16, 1846, when, a line of wires through the City of Washington having been made to connect the United States Naval Observatory with the High School Observatory at Philadelphia, signals were exchanged between these stations. At the Washington Observatory, Professors Walker and Keith, with Lieutenant, now Admiral, Almy, U. S. N., observed at the same instant of absolute time with that of Philadelphia, transmitting their observations through the striking of a delicately poised keeper of an electro-magnet. Signals would also have been exchanged with the Jersey City station of Professor Loomis, had not the insulation been imperfect and the Washington and Jersey City telegraph offices been out of connection. The Washington Observatory was reported as 7 minutes 34.306 seconds west of the High School, Philadelphia. The full report of this longitude determination by telegraph will be found in the Coast Survey Report for 1846, and in the annals of Harvard College.

THE WORLD'S LINES TO-DAY.

The sum total of lines through the principal countries of the world, now foots up a distance nearly fourteen times the circumference of the globe, or once and a-half times a journey to the moon. Of this total the United States lines extend 85,585 miles; Great Britain at home and through her foreign domain, 66,101; Russia crosses Europe and Asia with lines 34,914; France, 30,779; and the German Empire, 18,999. This is the history of the thirty years since Morse laid the first inch of wire the world ever saw in working order. Would it not be a proud illustration of American genius, if, at our coming Centennial, Professor Morse's report to Congress, June 3, 1844, should stand alongside of a comprehensive chart, which should show American lines stretching over a space three times the circumference of the globe, and in foreign lands stretched by the hands of others to more than three hundred thousand miles of perpetual and instantaneous intercourse!!

Very little reference has been made in this article to the marvelous extension of submarine cables since the birth of the earliest and shortest lived—the first between Dover and Calais in 1850. It will be remembered that up to the year 1858, when the first Atlantic cable was laid, no cable longer than 350 miles had been submerged; but the honor of being the original projector of ocean cables is accorded by the world to Cyrus W. Field, to whom Congress voted thanks and a gold medal in 1866, and to whom the International Exhibition in Paris, 1867, awarded the grand prize "for the promoting the system of ocean telegraphy." The civilized world awaits with impatience the cable between California, Japan and China, for which Mr. Field has succeeded in obtaining an act authorizing the employment of the United States navy to take deep sea soundings.

When the Pacific cable shall have been laid—as perhaps it will be in the year 1876-77—just a quarter of a century will have elapsed since the submerging of the first successful sub-marine cable of 1851, from Dover to Calais. The language of a poem written at the date of that event, and then thought rashly prophetic, will fully have become prose and truth. The sea will be

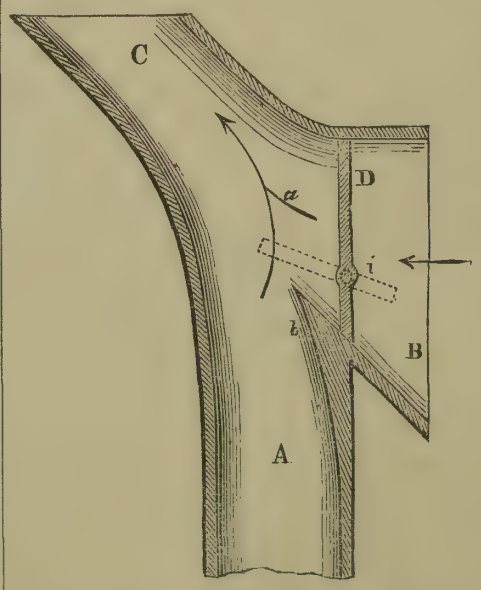
> "The means
> Of thought-swift messengers beneath its waves,
> Till England whispers India in the ear,
> America—North, South—from pole to pole—
> And words of friendship may pass around the world
> Between the dawn and noon."

J. E. N.

LANSTON'S LOCOMOTIVE SMOKE-STACK.

A recent and singular accident occurred, in which the ordinary screen spark-arrester of a locomotive became so completely clogged with cinders as to prevent the exit of the products of combustion, causing a serious explosion when the fire-door was opened.

In view of this occurrence, of the constant expense of renewing even these defective screens, and of the fires occasioned by sparks from passing engines (to say nothing of the pain and injury to eyesight, and the griming of passengers' skin and clothes from cinders), the invention noted below is worthy our attention.



The cut given herewith shows the longitudinal section of a locomotive smoke-stack, designed to abate, without danger, the cinder and coal-smoke nuisance; to prevent fires originating from sparks, and increase combustion and steam-making power.

To the upper part of an ordinary locomotive smoke-stack there is attached, in front, a flaring mouth (B), which, as well as the vertical passage of the stack (A), opens into an ejector or rearward pointing exit (C). There is a contracted throat (*a*) formed in part by the deflecting lip (*b*), which last serves as a guide in giving direction to the inclined ejector (C).

When the locomotive is running forward, the mouth-piece (B) will gather air in large quantities, which air will pass over the cylindrical portion of the stack (creating a partial vacuum, and thus increasing the draft), and will be forcibly driven through the ejector (C), carrying with it the sparks, smoke and cinders, sending them high in the air, consuming the sparks in the increased draft. The train will pass beneath them before they fall. The damper (*i*) regulates the amount of draught. An automatic spark-arrester (not shown in the cut), consisting of a properly-perforated disk, is in place when the engine is standing or running at slow speed.

The inventor is Tolbert Lanston, of Washington, D. C. †

The Polytechnic Review.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, Ph. D., ROBERT GRIMSHAW, Ph. D., } Editors and Proprietors.

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ON TURBINE WHEELS.

By Emile Geyelin.

[*Read before the Sheffield Scientific School, New Haven.*]

The subject to which I would call your attention this evening, is that of *Turbines*. Before defining the term, I would say that "water," the element made use of, having a given weight, practically 62½ lbs. per cubic foot, becomes a source of power when that weight, owing to the topographical formation of the country, can reach a lower level, and that power is proportionate to the quantity of water as well as to the height it is allowed to fall—power being the product of weight multiplied by velocity.

The instruments used, as you all know, are water-wheels, and I might add water-engines. Undershot, breast and overshot wheels form one class, turbines form another; the distinguishing features being that whereas in the first class the water is allowed to act more by its weight, in the turbine class it is allowed to act more by the speed due to the fall under which it operates. The term turbine is derived from the latin "*turbo, turbinis, a whirl or top.* It would imply, and, in fact, I have seen it often stated that it means water-wheels turning on vertical axes; but it is not necessarily so, since they are, especially when brought to use under high falls, coupled together on a horizontal shaft, and in that position produce satisfactory results. The water being admitted in opposite directions, neutralizes the great pressure that would otherwise be on the step.

A review of the development of the *turbine* is most interesting; but do not look for any gigantic strides, such as the introduction of the railroad and the telegraph have made in the first half of this century. But admire the results, that through patient labor of years, step by step, man has learned to avail himself of nearly of the whole of nature's power in water, and with such certainty too, that we look to its greatly accumulated force as an assistance to us, with the same confidence as we look to the daily rising of the sun.

Thousands upon thousands of our fellow-beings derive a livelihood through their agency, and their effect on the wealth of a people can be read in the plainest of languages by looking at New England to-day. Holyoke, Lowell, Lawrence, Manchester, those young giants whose wealth is wholly created by water-power as developed by turbines, are but a fraction of what New England has already accumulated from its vast resources. Large amounts lie yet dormant in her streams, to be called into usefulness by her future engineers and capitalists.

Let us now take a retrograde look and follow the gradual development of the water-wheel. At best we can but slightly touch a subject of which volumes may be profitably written. One word of the Flutter wheel—that most primitive structure. It seems like the first born—look for it in the backwoods far from human centres. Water may be plenty but the means are scant. The noise of the water as it splashes on the rudely shaped buckets will attract you towards it. Most likely, in a picturesque spot, you will find it, perched on moss-grown rocks, a slender axle holding a frame to which are secured a few plates. No formulas laden with Sinus-Coxinus—cube root—has given direction to its simple form. Shall we value it less for it? Let the tourist say, who, in the fragrant atmosphere of its surrounding pine and hemlock, has watched its unskilled efforts to shape a few boards.

First cousin to the flutter wheel we have the undershot wheel; more pretentious in its fitting apron, whereby less camboling of the water is allowed, as it comes dashing along. Still, like the user of an unknown power, much of its effect is lost. Look at their straight plates. Note how the water strikes them unprepared, to be left free a few moments later to continue its downward course. Are you surprised when told that one-third of the *vis viva* is all that these wheels develop? At this step science lends its living help. First note how it bends the bucket, into flat surfaces at varying obtuse angles; then to the graceful curve of the "Poncelet wheel." No sudden shock here; the plates quietly receive the pressure of the water, and like a kind friend, hold it in its folds to the very last. As a consequence, as high as sixty per cent. of force of the water have been developed by these wheels. The undershot wheels are adapted to low falls, and specially where slow motion is required, such as for the purpose of forcing air or water; but even in these conditions the turbines gradually take their places.

OVERSHOT AND BREAST WHEELS.

Many, no doubt, can remember when no other kind of water-wheels would have found approval; and this day, for a small varying stream, what can give better returns than the slow, patient overshot wheel, waiting for the water as it comes filling bucket after bucket, and turning round when ready with its well filled side?

It is not in this puny capacity, however, that the merits of the overshot or breast wheel should be based. Years ago many a stately factory was propelled by them. But valuable as they are in their application to falls varying from twelve to sixty feet, they have objectionable features which their rival the turbine has not; they are therefore fast losing ground.

Let us examine these objections. We have, for instance, the comparatively large size, especially where a large power is required in a concentrated form, such as the propelling of a large cotton or woollen mill. Again the fact that for the most cases wood is employed in their construction, which renders them short-lived and liable to many stoppages and repairs. We have also the necessity of having them housed in winter to prevent the ice from forming on their buckets; and last, but not least, we have as an objection, the loss of power by friction, created by the changing of their slow motion to the high one of the main shaft, which in most mills amounts to an increase from ten to twenty fold. All these objections are common to both the breast and overshot wheels, but the breast wheel presents comparative advantages over the overshot, which renders the preference for the turbine over the former less marked.

Take, for instance, a stream wherein the water-level varies; the breast wheel, with the arrangement of gate, can adapt itself more readily than the overshot wheel. When the upper level falls say eighteen inches, it draws from the lower gate; whereas the overshot wheels, unless originally constructed with a pressure greater than necessary in the ordinary stages of the stream, will not be able to receive as much water as needed, owing to the reduced pressure over the gate. Another advantage of the breast wheel is that the water, as it leaves the wheel, is forced away; whereas the water, as it leaves the overshot wheel, is, to some extent, drawn under—thus submerging the buckets to some extent. In the overshot wheel, also, much of the water leaves the wheel before the lower level is reached, and therefore its developed duty is proportionably lessened.

Though overshot and breast wheels are not to receive our special attention on this occasion, I have dwelt somewhat at length on their main features, so as to be better prepared to review the second class of water-wheels, namely:

TURBINES.

How far back water-wheels revolving on vertical axes, or, to speak more properly, water-wheels depending more on velocity than on gravity, have been treated, I am unable to say; nor does it matter much. Quite certain it is, however, that fair specimens were left in Spain by the same people who left the Alhambra and other architectural wonders we admire even now. Belidor, the famous hydraulic engineer, who, a century and a-half ago, in describing the fountains of Marly, amongst other kindred subjects gives us descriptions and plans of water-wheels belonging to this class. Here is an exact copy of it. Examine its quaint mechanical surroundings. To you, mechanics, it is a peep into the past. Examine the shape. It, you can readily conjecture, has never passed through a blast furnace—such mammoths as we know them this day—or felt the pressure of iron rollers to give it shape, as shafts for this kind of work are shaped in our time. No such appliances existed there. The early part of Louis the Fifteenth's reign, to which Belidor carries us back, though very rich in all branches of art, was dark indeed in metallurgical lore. A rude Catalan furnace no doubt converted it directly from the ore into a mass, afterwards shaped by the hammer. It is by close examination of *minutiæ* that we can establish the advance in mechanical arts, with the same certainty that Cuvier constructs the frame of an antediluvian animal by the finding of a single bone, or a Lyell points out a geological era by the finding of a stone on the roadside.

Until the beginning of the present century the record of advance made in the construction of turbines is not worth stating; but the earlier years of the nineteenth century exhibit the fruit of patient labor, as shown in the Fourneyron turbine. This turbine was improved, both in detail and in efficiency, by two of New England's honored sons, Uriah H. Boyden and James B. Francis—the former of whom can be considered its introducer into the mills of the United States. The perfection of their work rendered possible the great accumulation of power, whereby so many human hives are enabled to labor with profit to themselves, and to change the rocky hills into green and enlightened homes.

To state that the Fourneyron turbine was the only one of any merit, even a quarter of a century ago, would not be correct, since formidable rivals, especially those offering the advantage of smaller cost, soon made their appearance, and year by year since these new or fancied new applications of the water turned up; until now, the turbine family is so large that its very names become bewildering.

In a theoretical point of view, matters become much more simple, since many of the turbine wheels known to the public are but combinations, and sometimes simply poor imitations of the parent stock.

For the purpose merely of tracing the analogy of the different kinds of turbines, I should like you to note that in the simplest form, a jet, and in more perfect forms, a series of jets, gradually prepare the water to strike the plates of the revolving wheel. It is in the perfection of the direction of these jets, and the corresponding area of a section of them to the area of the openings for discharge in the revolving wheel, that the main advantage of a turbine lies. The better class of turbines embody the principle of reaction, whereby an additional force is obtained.

The *Scroll*, *Reynolds*, *Trips* and *Parker* wheels illustrate the principle of a single jet. The water is led to the wheel through a contracted channel, and by increased velocity strikes the plates of the revolving wheel. The Scroll, Reynolds and Trips, by the eccentric form of the casing, are able to act on the greater part of the periphery. The additional velocity to reach the extreme points, created by the contraction of the inlet, must always be obtained at the sacrifice of power, since the maximum effect of the water can only be obtained when the full pressure due to the fall is brought into action at the first point of contact with the wheel, which must be so constructed and speeded that the water will leave the wheel with the minimum of velocity. The wheels above named can *not* thus lay claim to high duty. From the simplicity of their construction, and especially where great economy of water is *not* necessary, they are much used. They are the pioneers to prepare the way for a more economical class of wheels to take their places.

Before speaking of the wheels where a series of jets are used in connection with the reaction principle, I would call your attention to the wheel acting *solely on the reaction principle.* In its primitive form it is known as *Barker's* wheel. A hollow, upright tube, through which the water is led to two arms, near the extremities, and on the sides of each arm are openings for the escape of the water; this simple construction comprises all the component parts of a Barker's wheel. A better form of this wheel, made with a closer application of hydraulic laws, becomes the "Scotch motor," in which the water is brought in an ample tube to two gradually diminishing and gracefully curved arms, whereby the water is allowed to retain much of the pressure due to the difference of level under which it operates, and thus produce results which render it a most desirable motor; particularly where a constant changing of power is desired. The most successful application of that

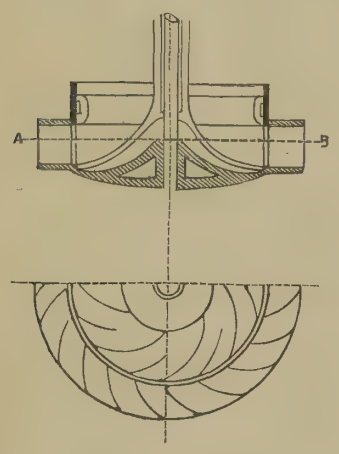
class of motors is at the Morris Canal, where they are used to propel the winding apparatus whereby canal boats are raised and lowered. Their construction is so plain that they have proved most durable under quite unfavorable circumstances.

This reaction or retrograde force is thus the *additional* force whereby the highest returns of the water have been obtained. The first one to apply the double sources of power—*impact* and *reaction*—was Fourneyron.

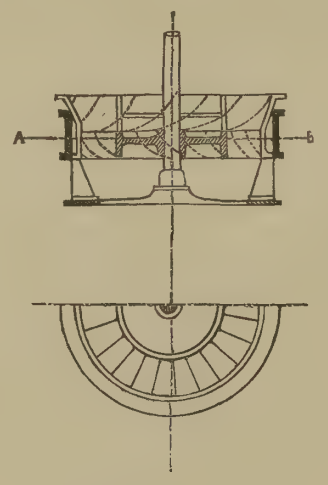
The turbine represented on the screen is an exact copy of one built by Fourneyron himself, forty years ago. Were I able to give you on the same screen the same class of turbines as constructed by Boyden & Francis, you could not avoid admiration for the thoroughness of their researches in finding, applying and perfecting of curves, and for the mechanical appliances whereby the water is divided and prepared, from which curves and appliances were derived those astounding results (92 per cent.) of the total efficiency of the water power; that is, of what power it would require to replace back again in the basin the water used in propulsion. Notice the avoidance of sudden change of direction of the water, which, you will observe, is brought in a spacious conduit, whereby no great velocity is created. Standard velocity being from 2 to 3 feet per second, nearly all is saved for the time of action on the wheel; from the base it is led by well formed cylindrical curves, secured on a stationary disk, to the plates of the movable wheel. The angle at which the water leaves the guide plates is calculated to strike the plates as near the tangent as possible. The angle is in the best wheels from 14° to 15° to the tangent, which becomes the angle on which the force is applied. By a gradual contraction of the space between the plates of the revolving wheel, the water is brought to the point of discharge, which is so arranged as to direct its retrograding force so as to bring the resultant force at a still more reduced angle to the tangent. Careful computations make the ratio of forces as 8 is to 2.

In the year 1849, Jonval gave a new turbine to the world, which embodied a novel feature, in France at least, where it was invented, namely, the application of the vacuum. But a number of years previous, Zebulon Parker, in the State of Ohio, made practical applications of it in this country; he named it the draft tube. This draft tube is an air-tight casing, in which the water discharges after it has left the turbine; its lower extremity is submerged in the tail-race water, thus excluding the air. The practical effect is that a turbine provided with this draft tube can be placed between both levels that constitute the fall, and produce the same result as if the turbine were placed at the bottom of the fall. Where it is not desirable to make deep excavations, this application of draft tube becomes valuable. Before going any further, I would state that all downward and inward discharge turbines invented since are making use of this feature.

The action of the water is somewhat different in the Jonval from what it is in the Fourneyron. A series of carefully prepared plates prepare the water for action, by directing it from the perpendicular to an angle of 16° with the horizontal surface when it is brought in contact with the plates of the revolving wheel, which plates are so placed as to receive the entering water as favorably as it is received by a Fourneyron wheel; but instead of the water discharging outward in the Jonval turbine it discharges downward. As usual with all downward discharge wheels, the *Jonval* has the merit of compactness, and in connection with the fact of being able to place it in any position between the two levels, this makes it a very desirable hydraulic motor.



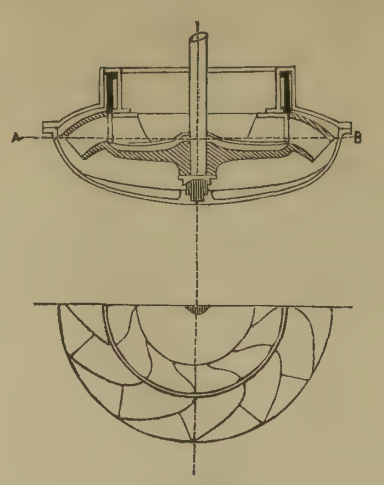
FOURNEYRON.



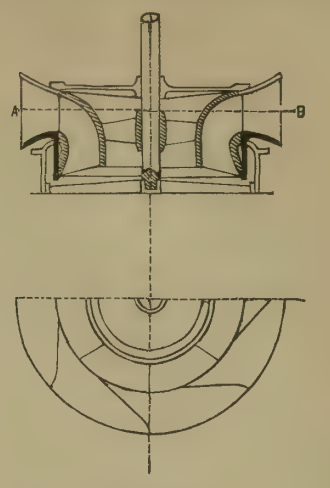
JONVAL.

Let us now pass in review the remainder of the turbines most favorably known. The charts represent the Swain, the Leffel (double), the Risdon, the American, and the Excelsior. All these wheels, either discharging inward or outward, make use of the double action of impact and reaction, and were they all constructed by the same mechanical engineer, very little difference would be found in the return of power from any given fall and quantity of water. The principal cause of loss of efficiency is to be found in the want of proper mechanical and engineering skill in adapting any particular wheel to the conditions under which it is to work, and specially so is the operation of gate or gates wherewith to open, close, or regulate the quantity of water to be used. For the purpose of facilitating the comparison, I have shown the sections of wheels in cross lines, and of the gate in solid black.

When performing an equal duty with an invariable supply of water, the gate of a turbine is used merely to start and stop. This condition, however, seldom occurs. Either the resistance varies, or the head, or height of column of the water varies; and there are two modes of overcoming these variations. The first is to have a series of turbines, sometimes of varying power, connected to a general shaft, and thus connect or detach a turbine as wanted. This plan is certainly good; but often for want of space, or with the view to simplicity and compactness, it is desired to obtain the same results with one turbine. The second mode is that of closing or opening the gate or gates, and thus regulating the supply of water to meet the variation of head or the variation of resistance, or the effect of both variations combined. It stands to reason that the turbine which retains the two elements of power in their greatest perfection, is the one that comes nearest to that desideratum of working the best results under the above named variations. The gate of the Fourneyron turbine, you will observe, is a ring closing between the guide and movable wheel. The effect of this gate on the stream of water must be bad, since it brings

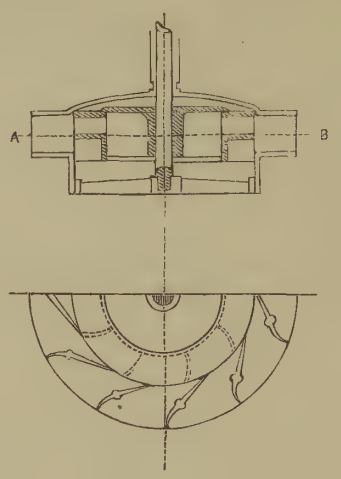


EXCELSIOR.

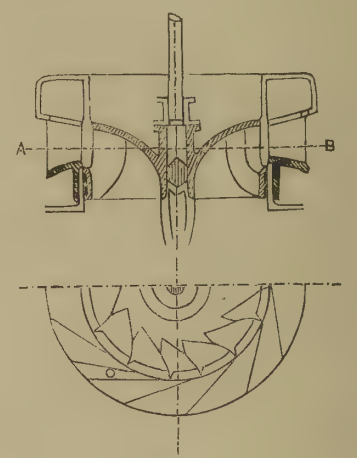


RISDON.

the water by an abrupt closure or stoppage, into a flat, thin sheet, which, after passing beyond the gate, is left free to enlarge in thickness, on its way to the outer periphery, with not enough pressure left to act upon the wheel. Of course it would be possible for the makers of the Fourneyron turbine to construct the outer, movable wheel in flat divisions, like a series of separate wheels, one upon another (in place of one wheel, as generally made), when each division of the wheel would only receive water as the gate is elevated; but this construction has not heretofore been used by them.



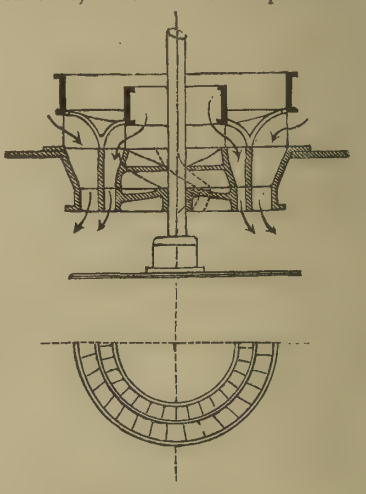
LEFFEL.



SWAIN.

The *Swain turbine*, you will note, has a better gate than the Fourneyron, since it brings the water between flat surfaces in any position it is put; but it is subject to the same objection as the Fourneyron gate, in not proportionally closing the movable wheel. The *Leffel* wheel presents the same feature as the Swain, of directing the water between the flat, though contracted, passage ways to the point of action, but with it also a corresponding contraction is not established in the movable wheel. The same remarks may be applied to the American turbine.

These conditions of imperfect action of the gate as usually applied to turbine wheels have led me to adopt a plan of gate for the Jonval turbine, which is here represented. It will be noticed that the division of the water, in halves or in thirds, is complete both in leading plates and in the movable wheel, and the streams do not meet until their duty on the turbine is performed. The water thus gives its proportionate pressure on the wheel as it enters it and as it leaves it. It is hardly necessary to say that careful experiments have proved the advantage of this plan of turbines. The gate of the ordinary Jonval is generally placed at the outlet, where it is free from any injury; and to perform the duty of starting and stopping the wheel, no simpler and stronger arrangement could be desired; but for variable power or variable quantities of the water, the plan was a most unsuitable one, as it removed the point of contraction from the wheel altogether, and merely made resistance to the flow of water beyond it.



IMPROVED JONVAL.

I will close my remarks on turbines by alluding to one of the most interesting features of these water wheels—it is their practical application to any height of fall. I have seen the famous turbine of St. Blasien, made by Fourneyron, operating under 350 English feet fall, giving 73 horse power, which is so well known to readers on this subject of turbines; but as a parallel example to this one, I desire to record one made by me in 1854, for Saltillo, Mexico, which was a double turbine (that is a turbine receiving water *between* two movable wheels on the same shaft, which counterbalanced each other, and avoided the necessity of resisting the thrust from the head of water) for 160 feet fall, producing 125 horse power, and turning at a speed of 1,850 revolutions per hour. This double turbine, though only 11 inches in diameter, propels a cotton mill of 10,000 spindles.

And now, gentlemen, to show what importance is attached in the practical application of turbines, I have to say that the U. S. Centennial Exhibition has been engaged in preparing a most complete testing apparatus, where the world at large is invited to bring its wheels to be tested by a competent committee of mechanics. Let us hope that in the ensuing competition the results will establish the superiority of the turbines of the United States.

THE REMOVAL OF NIGHT-SOIL.

II.

The second mode of removing night soil is the fixed-pipe system. By this the *excretæ* are received at once into pipes fixed in the building, and carried into either (1) a cess-pool, (2) a sewer, or (3) an open stream of water. The pipes are either flushed with water or left uncleansed. If flushed with water the supply may be either constant or intermittent. The intermittent water supply is either left to the discretion of the one using the closet, or made automatic.

Discharge into a cess-pool or sewer necessitates greater precautions than when an open stream of water receives the fecal matters directly from the house-pipes; as there is a constant tendency to send foul gases up through the pipes unless these are *properly* ventilated. Where a cess-pool is used, the contents should be removed by the odorless excavating system, described in our March number.

The proper construction and maintenance of sewers may be alluded to at full length hereafter. Their discharge should not be permitted where it will foul streams of water to too great an extent.

The system of flushing with water, may, in some cases, where the reaches of pipe are short, large, and straight, and the ventilation positive and undoubted, be dispensed with; but such cases are extremely rare. Constant supply has the merit of keeping the pipes free from offensive matter. The objection to this system in most places is the expense; hence was devised the intermittent supply, dependent upon the thoughtfulness, &c., of the occupant of the closet, and certainly saving of water—so very saving that frequently no water is used, and the closets and their neighborhood become offensive and unwholesome. The automatic system compels the flushing of the closet at each time and moment of use—always providing that the water supply is unfailing. By one modification of it, the water is kept flowing the whole time of occupancy of the closet; by another, the supply is administered on rising, and irrespective of the time of occupancy.

Where the pipe-system is properly constructed and maintained, it is one of the greatest of modern conveniences; but where the work of manufacturing and setting the appliances and their connections, and the care in using them, is not precise and particular, there is no more disgusting nuisance, and no more deadly and insidious evil. Carelessness in setting and using amounts practically to having a "main" of typhoid fever always laid on into one's house or other quarters. Poor work and poor care in these matters should be detected by vigilant inspection, and punished by rigid enactments.

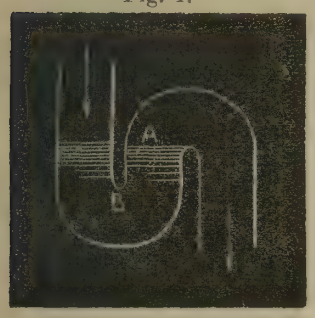
In proof that the many water-closets boasted entirely odorless, and free from escaping gases, *do* taint the air, we have only to note that silver-plating is seldom or never employed on their handles or pulls—nothing but nickel standing the tarnishing effect of the air near these "perfectly tight" closets.

How, when, and where water-closets were first introduced as a convenient mode of removing night-soil, our space does not permit us to chronicle. Water as an effectual cleansing agent to remove all traces of deposit would naturally be early suggested, and its use has at once been a wide-spread blessing and an insidious deathly curse.

The pipes which convey away the fecal matters are either open or "trapped." If open, and discharging into a pit or sewer, there is, under ordinary arrangements, nothing to prevent the foul gases of decomposition from arising and passing into the house to breed disease.

As many of these harmful gases are peculiarly noticeable to the sense of smell, the "trap" was adopted as a means of preventing any odors or gases from escaping through the upper orifice of the pipe. An ordinary trap is shown herewith in section.

Fig. 1.



With this appliance, theoretically, any offensive matters passing from above may be carried through and over the S-shaped bend, and the water remaining in the trap would serve as a seal to prevent the rise of gases from below, unless the upward pressure were sufficient to overbalance double the column between the levels A and B.

Practically, particles of unwholesome matter remain in the trap and decompose, giving off gases on each side of the bend. Moreover, the water in the trap freely absorbs the gases from below, and gives them off above. The gas pressure from the cess-pool often forces or unseals the trap; and again, the corrosive action of sewer gas frequently perforates these traps when of lead.

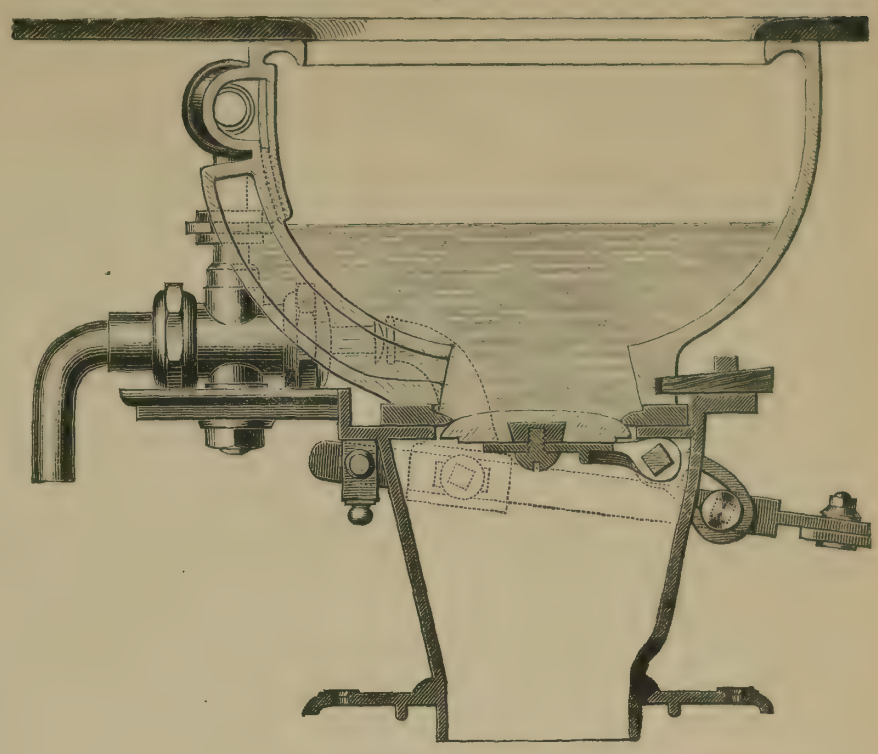
Additional protection was given by adding another hopper above the trap, and supplying this with a hinged metal "water-pan" to receive the *excretæ* temporarily. This is uptilted to drop the *excretæ* into the trap below, and the same device opens the water supply with the intention of flushing out the trap; the current being so adjusted as to fill the pan and seal the upper hopper from the trap, after the pan is again brought in place. This, however, merely delays the absorption of gases, and does not diminish the risk of unsealing by "forcing" from below. Moreover, the pan is found in practice to pack or jam fouled paper and solid matters between it and the hopper; the gases from these reaching the room with very little trouble.

Economy of water frequently leads to only partial flushing of the pan and trap; while the most liberal allowance of water does not always thoroughly cleanse the hopper, and never can prevent absorption in and forcing of the traps. The fouling of the hopper is by some makers nearly entirely obviated by having its neck very large and the back almost perpendicular.

The immediate use of putty and cement in setting water-closets deserves marked condemnation, as these absorb gases and liquids, and give them out again.

One form of water-closet (shown in section herewith) is designed to prevent the escape of any gases, by means of absorption or forcing from below, and to prevent any packing or jamming between pan and basin. No putty and cement are used. The basins are of unusual size, and retain a larger surface of water than the opening in the seat, thus avoiding soil touching any portion of the basin that is not protected by water. Instead of a hinged pan, a rounded porcelain disk, pressing tightly against a rubber valve-seat, closes the basin, making a joint that cannot be forced while closed. In this excellent closet, the only chance for gas to escape into the apartment is when the valve is open. Water poured into the hopper or drain-pipe must displace its volume of air or gas, which, under all the systems mentioned, must escape through the bowl and into the apartment.

Fig. 2.



The problem then is how to prevent this escape of gas through the bowl—and the solution lies in giving it another and more convenient exit—or, in other words, *ventilating*. Ventilation implies removing foul air, and should imply admitting fresh to take its place.

(*To be Continued.*)

WATER SUPPLY FOR CITIES.

It has now become a necessity (whereas formerly it was considered only a convenience) to furnish cities with a large and inexpensive supply of water for domestic, manufacturing and fire-subduing purposes. Even the city of Tiflis, in the Caucasus, has been agitated by the cry for water, and estimates are now being made by competing bidders to carry the improvements of the nineteenth century into that district, supposed to be the cradle of the human race; while ancient Beirout can already show modern water-works, and her century-trodden pavements bear plates with the initials "B. W. W.," as in Boston. The systems by which cities may be supplied with water, are embraced in the following heads:

(*I*) *Supply with Reservoir;* (*II*) *Pumped Supply with Stand-pipe, and* (*III*) *Direct Pumped Supply.* These we shall consider briefly.

I. *Supply with Reservoir.*—This is the oldest and most expensive method, but, for many reasons, the best. Where the immense first cost is not an objection, there is manifold advantage in storing up, against drought or accident to pumping machinery, a large body of water; which may also have opportunity to deposit sediment and impurities. Again, facility is given for frequent or extended inspection or repairs of machinery, and uniform pressure is maintained. In time of long-continued drought, the storage reservoirs frequently avert justly calamitous results. It is obvious that this system admits of using either a gravity supply (by natural flow) or a pumped supply.

II. *Pumped Supply with Stand-pipe.*—This is the second best mode of maintaining a uniform pressure on the supply pipes; but no prolonged stoppage of the engine is permitted, although there is sufficient time for repairing, etc. Philadelphia, in times past, used four pipes, varying from 130 to 170 feet in height; while Erie, Pa., boasts of one 217 feet high. Of course all impurities held in suspension are forced through the supply-pipe to the consumers, having no time to settle, unless a filter-bed, or subsiding reservoir, or carefully constructed wells, be used to receive the water prior to forcing into the stand-pipe. This system of supply properly necessitates double engines, hands, etc.; otherwise, any accidental derangement would be fatal.

III. *Direct Pumped Supply,* without reservoir or stand-pipe. This mode was first introduced in 1582, at London Bridge, where four alternating piston pumps were driven by a water-wheel, and had a good supplying capacity. The growing wants of the city, the impurity of the water, and other causes, led to its abandonment fully a century ago. Recently this system has been introduced into this country, rotary engines and pumps being, in some cases, employed in combination with the reciprocating system. The comparatively small outlay required to introduce this method recommends it. A stand-pipe or reservoir may be added with advantage when the necessary funds are available. Vigilance is an incessant and arbitrary requirement, as a fire or conflagration may break out at any minute, and not be conquered for days or weeks. In connection with this system, unusually heavy distributing mains and pipes are needed to stand the pressure required for fire purposes; the danger of leaking joints is greater, and it is unwise to bring upon all the service-pipes, water-backs and range-boilers, the pressure required at fires, without some regulators interposed. If separate mains for fire purposes were used with the "direct supply" system (as, some day, they will be for the purpose named, whatever the source of water), the objections to the system will be lessened.

The problem of water supply is being slowly worked out—not more slowly, however, than that of Fire Proof Construction—of which, "more anon." †

A Syren Fog Signal House is to be established at St. Ann's Head, Wales. The motive power will be furnished by caloric engines.

Russian Railways.—Recent statistics give 2,289 locomotives; 5,112 carriages, and 48,614 trucks.

Edge Tools may be sharpened by immersion for half an hour in water containing 5 per cent. of muriatic acid, which corrodes away the softer metal.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

Compound Corliss Engine.—Engineering gives details and indicator diagrams of a compound Corliss engine of 300 indicated H. P., showing 13 lb. of water used per H. P. per hour, equivalent to a consumption of 1.3 lb. of coal per indicated H. P. per hour, with a boiler evaporating 10 lbs. of water per lb. of coal.

Rolling Bridge over the Thames.—Engineering gives drawings and details of a proposed rolling bridge over the Thames, designed by G. Barclay Bruce. The plans show 6 piers across the river, 100 feet apart, and on each of these rollers and machinery for propelling the platform across the river. The rolling platform, which is 300 feet long and 100 feet wide, rests always on at least two piers, while a clear water-way of 700 feet is always afforded. The weight of the moving structure, fully loaded with 1½ cwt. per foot, is estimated at 5000 tons; the total cost, including piers and machinery, £144,000. The estimate of carrying capacity is 100 vehicles and 1400 passengers at each crossing; time of crossing three minutes, *exclusive* of delays from shipping.

THE 81-TON GUN has had its bore enlarged from 14½ to 15 inches, and a third series of rounds fired, the results being given below:

No. of Round.	Size of Powder.	Weight of Powder Charge.	Weight of Projectile.	Muzzle Velocity.	Total Energy in Foot-tons.	Foot-tons of Energy per inch of Shot's Circumference.	Foot-tons of Energy per lb. of Powder.	Mean Pressure in Gun.
	in.	lbs.	lbs.	ft.	tons.	tons.	tons.	tons per sq. in.
1	1.7	220	1260	1513	19,994	424.32	90.88	21.
2	1 7	230	1260	1546	20,789	441.19	90.39	22.
3	1.7	220	1460	1471	21,907	464.92	99.58	26.2
4	2.	250	1260	1536	20,607	437.33	80.25	23.2
5	2.	220	1460	1364	18,829	399.59	85.58	24·4
6	1.7	220	1460	1424	20,529	435.60	93.31	23.8

The gun will shortly be transferred to the long ranges and tried against armor-plates. The ultimate capacity expected when the maximum bore of 16 inches is reached, is a penetration of 27 inches of solid armor at 1000 yards, with an 1800 lb. shot.—*Abstract from Engineering.*

MR. JAMES M. BLANCHARD suggests case-hardening car-axle journals as a means of decreasing friction, saving lubricant, and increasing the life of the journal.

AN improved signal light for freight cars has a revolving octagon frame, glazed in alternating colors, and operated from the axle. It is designed to show whether the car is moving, and, if so, how fast.

M. HALLEZ, of Lille, has invented an appliance by means of which, on the occurrence of an accident in any part of the factory, the steam may instantly be shut off from the engine, and the machinery stopped at once. A torsion or coil spring is in constant tension, and by telegraphic or mechanical communication with buttons in all parts of the factory, the spring is released and the throttle closed.

Building in Concrete.—Mr. Ward, of Port Chester, N. Y., has erected a fireproof house. The walls, partitions, floors, stairs, cornices, dormers, roof, and balconies weighing nearly four tons, projecting four feet from the building, are all one solid indestructible mass. Iron girders, cased in *beton*, are used in the floors and roof, forming deeply coffered ceilings; but Mr. Embler would ignore the use of iron entirely, were he to repeat the work, as he deems the concrete alone sufficiently strong. The iron beams are nowhere nearer than 7½ feet between centres. A floor of 18 feet span sustains a weight of 30 tons of cement, in barrels, without any deflection. The roofs are the finest specimens of plastic construction in this country. There is a splendid circular Tuscan colonnade. The building is two stories and Mansard, with dormers. There are two Norman towers, one 70 feet high. The outer walls are two feet thick, with circular heating flues running up and connecting with the spaces between floors and ceilings. The partitions have similar heating flues. There are also ventilating flues in walls and partitions. There are massive concrete chimney pieces. There are partitions 13 feet high, 1 and 2 inches thick, firm as a rock. But one skilled workman was employed beside the superintendent. The cost is one-half less than for cut stone, brick and mortar.

Quick Time.—The steamer Germanic made the run from Sandy Hook to Queenstown in 7 days, 15 hours, 17 minutes, traversing 2894 knots, at the rate of 370 knots per day, or 15.8 per hour. The mean displacement was 8525 tons; mean pressure in boiler, 63 lbs.; mean vacuum in condensers, 27 inches; mean revolutions, 55.57 per minute; mean indicated horse-power, 5434.

THE *American Builder* suggests external chimneys for country residences. For philanthropists, desiring to warm the adjacent counties, the idea is a good one.

Quick Tunneling.—The Hour gravely announces that the St. Gothard tunnel, between January 1 and January 7, was pushed 9 miles, 800 metres from one end, and 26 miles, 100 metres from the other, or in all 35 miles, 900 metres, or 5 miles, 130 metres per day! As the tunnel will be but 9.3 miles long, the contractors must have the ends of the hole projecting many miles into the adjacent country. This is something like tunneling!

Wear of Axle Bearings.—The following table, showing the comparative wear of axle bearings on one Austrian, one German and one Belgian Railroad, is taken from *The Engineer* and reduced by the *Railroad Gazette* to United States gold currency:

KINDS OF BEARING.	Composition in 100 lbs. alloy.			Cost per 100 lbs.*	Miles run per lb.	Wear per 100 miles for four bearings.
	Copper.	Tin.	Antimony.			
Gun Metal	83	17	..	$28.60	25,489	200 grs.†
" "	82	18	..	28.68	27,918	252 "
White Metal	3	90	7	32.85	22,075	366 "
" "	5	85	10	32.27	24,857	284 "
Lead Composition—lead 84, antimony 16.	..	..	..	13.04	22,921	308 "
Phosphor Bronze	..	..	..	38.50	121,034	58 "
Gun Metal on brake cars	82	18	..	28.68	2,576	274 "
Phosphor Bronze on brake cars	..	..	..	38.50	30,290	23 "

* Including melting expenses, loss, &c.
† 7,000 grains per pound.

The Master Car Builders' Association Committee circulars are now out, requesting data for their reports at convention in New York, June 14th. The subjects are as follows:

(1) Best Remedy for Hot Journals; their Treatment; Best Metals for Bearings; Best Lubricating Oils and Packing Materials. J. W. Holmes, Chairman, Galion, Ohio.

(2) Best and most Economical Truck for Freight Cars; Position of Brakes and Brake-Shaft. D. Hoit, Chairman, West Albany, N. Y.

(3) Car-Wheels; Method of Fitting; Flange Wear and Breakage. John Kirby, Chairman, Cleveland, Ohio.

(4) Elliptic, Combination and other Car Springs used on Passenger Cars. B. K. Verbryck, Chairman, Chicago, Ill.

(5) Improvements made during the coming year in the Design, Construction and Materials of Cars. M. N. Forney, Chairman, 73 Broadway, N. Y.

(6) Draw Bars and Buffers. F. D. Adams, Chairman, Springfield, Mass.

(7) Blank Forms to be used by Car Builders for Procuring Statistics and Information Relative to the Repairing of Cars. John McVay, Chairman, P., C. and St. L. R. R., Cincinnati, Ohio.

The circulars in full are published in the *National Car Builder*, for March.

THE railroads of this country are said to use 160,000,000 ties annually, leveling 150,000 acres of trees to supply them. Ties last an average of seven years.

Iron Freight Cars are now built in Providence, R. I. The ordinary platform car weighs 6 tons, and its load is from 8 or 10 to 12 tons. The ordinary car, carrying 10 tons, must carry a dead weight of 6 tons, while the iron car is said to carry 20 tons with a dead weight of but 3 tons.

THE Lobdell Car Wheel Co., of Wilmington, Del., is constructing a lathe for turning chilled wheels either on or off the axle. Such wheels have developed very valuable qualities, outwearing steel-tired wheels.

American Tunneling.—Mr. Henry S. Drinker, E. M., of Philadelphia, has received replies from over 1200 engineers to his circulars asking for data of American tunnels; and the first part of the work is nearly ready for the press.

A "*Beam-end Protector*" consists of a tin hood fitting over the ends of beams or joists, to protect them from damp and fire. *Industrial Design.*—Michigan has endowed a Professorship of Architecture and Design at her University.

The U. S. Metal Testing Commission is making extensive preparations for a thorough series of mechanical and chemical tests of metals, lubricants, &c.

Polishing Machine.—An improved machine for polishing wood mouldings, &c., feeds the surface under a reciprocating rubber. This last is a reverse mould in concrete, backed by a box of emery.

Ice Machines.—Twenty-eight United States patents have been granted since January, 1872. "*Galvanizing*" sheet iron was introduced in 1847, by H. W. Crawford.

CHEMISTRY, TECHNOLOGY.

New Explosives.—Several references have lately been made to an explosive compound called Vigorite, which has been introduced to some extent in England, and which is affirmed to have the following composition, viz.: 25 to 50 per cent. of nitroline, 15 to 25 per cent. of saltpetre, 10 to 30 per cent. of chlorate of potassa, and 15 to 35 per cent. of cellulose. The *Scientific Press*, upon the subject of above title, affords us the additional statement that another explosive, recently invented by Falkenstein, and apparently made with woody fibre prepared with nitro-glycerine, has been recently tested in various mines in upper Silesia. The results are not on the whole unfavorable, but were not uniform. The substance has not (as was at first claimed for it by the inventor) five times the energy of an equal weight of ordinary blasting powder, and even four times was doubtful; but a threefold force may be readily conceded. The advantages claimed for the new(?) agent are that it will not explode on contact with open fire, and is but with difficulty exploded by concussion or friction, and that the strand match may be used to effect its explosion in a blast-hole. The powder is very light, and in the loose state burns very slowly. To determine the difference, if any, between this preparation and what are known as dualin or giant-powder—in which a vegetable powder is used as the carrier of the nitro-glycerine—no particulars are at hand.

Linoleum is the trade name of an article made from a mixture of pulverized cork and oxidized linseed oil, brought upon canvas. It has been largely introduced in England as a substitute for oil-cloth and other floor coverings. It is soft, elastic, impervious to moisture, non-absorbent of dust, and noiseless to the tread, and is made in simple or elegant designs to suit various requirements. It is affirmed to be very durable—superior in this respect to oil-cloth—and may be cleaned with water and brush when necessary. In this country it is just beginning to be popularly known.

A New Material for Paper Stock.—The *Journal Officiel Français* contains some interesting statements concerning the *Alfa*, a fibre-yielding plant, which flourishes upon the plateaus of Algeria, and which is affirmed to afford a substitute for rags in the manufacture of paper. It appears that its value has been recognized, and in 1874 not less than 60,000 tons of the material was collected and utilized for paper-making. The statement is added that there are more than 4,000,000 hectares (a hectare=11,966.4 square yards) in Algeria covered by this plant, which, if properly cultivated, and its product properly prepared for the market, would represent an immense value. This it is proposed to accomplish by a European colonization project. Amongst the several improvement schemes now under consideration, are to be enumerated several lines of railroad leading through the regions where this plant abounds, which, when built, would give a powerful impetus to a new industry of the kind above proposed.—*Deutsche Allgem. Polyt. Zeitung.*

Telegraphic.—Between England and her Indian Colonies there are at the present time two main lines of telegraphic communication; the one over Germany, Russia, Persia (Indo-European line), and the other over Lisbon, Gibraltar, Malta, Suez, Red Sea, Aden and Bombay (line of the Eastern and Eastern Extension Telegraph Co.). The first line is an entirely overland route, while the second is an entirely submarine one. A third line runs over Turkey to Fao, and through the Persian Gulf. The sub-marine line affords the most rapid transmission of dispatches. Since the month of November last this line has been interrupted, and the loss to the company has been very great, especially as the Red Sea cable communication has not yet been reëstablished.* To avoid future losses from the failure of cables, the companies interested in the sub-marine lines have determined to lay a second cable line between Suez and Aden, and Aden and Bombay.—*Deutsche Allgem. Polyt. Zeitung.* [*The Suez-Aden Cable has been repaired, and is reported to be now in excellent condition.—ED.]

Apparatus for Estimating Tannic Acid.—Müntz and Ranspacher's method is to pass the tannic acid solution through an untanned hide, which frees all the tannic acid and practically allows the other dissolved matters to pass through unabsorbed. Their apparatus is expensive and requires time to make. A device of William Thomson's, F. C. S., may be made in an hour at very slight cost. A leather disk is held by clamps between the mouths of two strong glass funnels of equal size. To the stem of the upper and inverted funnel is attached the stem of a long vertical funnel. The lowest funnel is inserted in any convenient flask. The solution is poured in the upper funnel and allowed to filter through the hide. From the difference in its specific gravity before and after filtration, the percentage of tannic acid may be estimated.

The Direct United States Cable Company announces that the late break in its line has been repaired, and that the same is now again in full working order. Some light may perhaps be cast upon the cause of the numerous accidents(?) which this company has suffered, by the following telegram sent from its representative on board the Faraday, on picking up the fractured end of the New Hampshire-Torbay cable broken on the 23d of January last. The dispatch appears to confirm the prevalent suspicion that there has been foul play in the matter, viz.: "End of Eastern piece up at 14 to 1 this morning, lat. 42.45; depth nearly 100 fathoms; damage caused by cutting with axe or hatchet; marks of three or four blows; cable apparently raised upon anchor; subsequently severed; no natural chafing; wires, abraded on under side of bend; eight cut through evenly; two broken after being weakened by hacking; condition excellent; compound off for 12 inches from each end; malice or wanton recklessness unquestionable; when cable was raised it might easily have been slipped." Since the above was written we have read the announcement that "the Direct Cable is again interrupted." The fault occurred on March 27th, and is in the shore section off the coast of Nova Scotia, near Torbay.

Production of a Patina on Zinc.—A solution of molybdic acid or of molybdate of ammonia in weak *aqua-regia*, or a solution of molybdic acid in an excess of strongly diluted soda lye, furnishes, according to M. de Kletzinsky, a very good bath with which to obtain a patina on objects cast in zinc. The objects are simply immersed in a bath, when they shortly acquire a brownish patina very agreeable to the sight, and having a characteristic iridescence. The effect here described is due to the formation of a thin film of oxide of molybdenum, which develops the colors of polarization, and which adheres strongly to the zinc.—*Le Technologiste.*

Fading Frescoes.—Not only the frescoes of the English Houses of Parliament are in a bad condition, but Baudry's fine paintings in the grand *foyer* of the (Paris) Grand Opera House, threaten soon to become things of the past. The gas has affected them badly and their bright coloring has suffered very much.

A Solid Hydrate of Hydrochloric Acid.—MM. Pierre and Puchot show that if commercial hydrochloric acid cooled down to a temperature of 22° C. (equivalent to 7½° Fahr.) is supersaturated with dry hydrochloric acid gas, an abundant crystallization ensues. These crystals are decomposed on exposure to the air, with the evolution of dense white fumes. In water they dissolve rapidly. Their composition is four equivalents of water to one of hydrochloric acid. The authors claim to have attained the temperature of—35° C. (—31° Fahr.) with mixtures of snow and hydrochloric acid, which they recommend as a freezing mixture.—*Chemical News.*

The Galvanic Deposition of Iron.—The peculiar value of iron as a covering for metallic objects has long been recognized, although thus far the methods that have been devised for obtaining suitable deposits of this metal have not been sufficiently developed to meet the requirements of practice. The following brief review of the subject, condensed from *The Practical Magazine*, may be of interest: Bœttger, as early as 1846, gave directions for obtaining galvanic deposits of iron, and employed for this purpose a solution of two parts of sulphate of iron, and three parts of sal-ammoniac; and in 1859, Jacquin adopted this method for steeling copper engraving plates. Klein improved upon the above, by substituting the sulphate of ammonia for the chloride, in a concentrated aqueous solution. As an anode, he took an iron plate, but found it expedient to connect with this a copper plate also. The deposits found by Klein were very hard and brittle, but were rendered ductile by heating to a red heat.

Varrentrapp connects an iron wire with the iron anode, and brings the anode and cathode within four or five inches of each other. He employs a solution containing four parts by weight of green vitriol and three of sal-ammoniac in thirty of water. When metal moulds are used, he proposes first to silver them, and then by means of sulphuretted hydrogen to give them a yellow tint. The iron deposit then comes away easily. It is of great consequence to pay attention to the regulation of the current, and a weak one is recommended, even if it somewhat lengthens the operation.

The use of galvanic deposits of iron is highly recommended for stamps, printing plates, clichés, &c., which may be rendered more durable and elegant by a subsequent nickelization.

Sodium Amalgam.—Mr. H. N. Draper, in the *Chemical News*, recommends the following method of preparing sodium amalgam, which he affirms is quite free from danger and inconvenience. The sodium is melted under paraffine, and the mercury is poured upon it in a thin stream. The union is effected without spirting, explosion, or even incandescence. If the quantity of mercury employed is such as to produce a solid amalgam, this will solidify before the paraffine, which may be poured off, and the amalgam cleansed from it with petroleum ether.

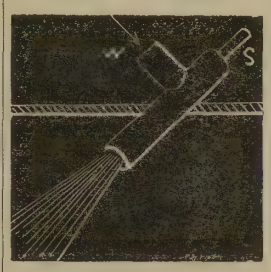
Preservation of the Dead.—The Brunetti method, by which Mazzini's body was preserved, is as follows: (1) the circulatory system is cleansed thoroughly by pure cold water for two to five hours; (2) alcohol is injected, say for fifteen minutes, to remove the water; (3) ether is injected to abstract the fatty matter, time, two to ten hours; (4) a strong solution of tannin is injected, two to ten hours; (5) the body is dried in a warm dried air-current. It is then hard and resists decay. Some specimens are as hard as stone.

Indigo.—Olpherts has used steam to heat to 111° the water used in steeping the plants. The result is an increase of 25 per cent. over the indigo obtained at 93°.

Condensed Beer.—The beer is boiled in a copper vacuum-pan, at a temperature of 130° to 160°, and a vacuum of 25 or 26 inches. The distilled alcohol is collected; then the resultant fluid is condensed to $\frac{1}{18}$, after which the alcohol is returned to it. The addition of water brings the beer back to its original bulk and properties.

Spontaneous Fires caused by Iron Rust.—An item, purporting to be from an English source, is at present going the rounds, from which it would appear that when iron is placed in contact with wood, excluded from the atmosphere, and aided by an increased temperature, the oxide is reduced to metallic iron, which, in the extremely pulverulent condition in which it exists, is capable, when subsequently exposed to the atmosphere, of spontaneously taking fire by its rapid absortion of oxygen (as in the analogous case of the spontaneous firing of freshly prepared iron by hydrogen, a favorite lecture-room experiment), and of raising the wood in immediate contact with it to a temperature far beyond that required for its ignition. The author of this plausible hypothesis thereupon draws the inference that when iron pipes employed for the circulation of any heating medium (steam, hot air, or water) are in contact with wood-work, and allowed to become rusty, the above described process is liable to take place, and he finds in this an explanation of many of the fires that periodically take place at the commencement of the winter season. While not denying the possibility of the production of ignition by wood, &c., in the manner above described, it appears to us, nevertheless, to be a somewhat far-fetched bit of theorizing; which, while it has the merit of being highly suggestive, will require the crucial test of an experimental demonstration to secure for it a place in the category of veritable causes of spontaneous fires.

Improvement in Sulphuric Acid Manufacture.—The accompanying engraving represents a device suggested by Sprengel some time ago, and employed with much success, for replacing by an atomized liquid (pulverized water the inventor terms it) the steam which is injected in the lead chambers in sulphuric acid manufacture. Through the side of the chamber, indicated in the cut, passes the atomizing tube, terminating in a brush of platinum wires, called the pulverizer. At S, a jet of steam is introduced under a pressure of two atmospheres, which violently projects upon the brush of platinum wires, shown in the engraving, the slender thread of cold water which enters the atomizer at W. 20 lbs. of steam about suffice to pulverize in this manner 80 lbs. of water, and an apparatus of the size of that represented in the figure is able to deliver 335 kilogrammes (737 lbs.) of water in 24 hours. A number of these jets are placed at equal distances apart about the sides of the chamber. Dr. Crookes affirms that the saving of fuel effected by the use of this simple device is estimated, by those manufacturers who have introduced its use, to be not less than two-thirds of that formerly used—or, to put it differently, the saving in steam, acid, nitre and labor is estimated to amount to five shillings per ton of acid.



Concerning Nickel-Plating.—Professor Böttger, as long ago as 1843, proposed the ammoniacal sulphate of nickel as a suitable salt for a nickel-plating bath. In order, however, that the covering of nickel shall have the greatest solidity, and at the same time the greatest elasticity, Mr. Keith has lately recommended the addition of either acetic, tartaric or citric acid. The following is the recipe for a nickelizing bath which is affirmed to afford most satisfactory results, viz.: Dissolve, in 10 litres of distilled water, 500 grammes of ammoniacal sulphate of nickel, 250 grammes of sulphate of ammonia, and 50 grammes of citric acid. Boil the solution for about a quarter of an hour, and add, in small particles, sufficient carbonate of ammonia to render it neutral. It is then filtered and left to cool. This bath demands a tolerably strong current, but it should not be too powerful, as otherwise the nickel surface will be matt and pulverulent. The operator may know when the current is sufficiently strong, by the disengagement of gas, not only at the anode, but also at the pieces to be plated, which represent the cathode. The zinc platinum element is recommended with sulphuric or nitric acid as the excitant, and an anode composed of a plate of platinum. By suspending in the bath a linen bag containing some oxide of nickel, from which it may renew itself, the same bath may be operated for a long time. It is *important* that the articles to be plated should be quite clean and free from verdigris, as a solid and brilliant coating is only formed on a perfectly clean surface. To obtain a matt coating it is recommended to previously bite the pieces in a bath of sulphuric acid. By the above procedure Mr. Keith has been able to obtain an irreproachable nickel-plating on copper, brass and iron, and it is employed with great success in the important establishment of the MM. Roseleur et de Plazanet, in Paris.—*Le Technologiste.*

Practical Uses of Salicylic Acid.—Wagner recommends this substance for the preservation of articles of food, especially meat. He employs a concentrated solution of the acid in water, with which he covers the meat, and preserves it in well closed vessels. In this way he has preserved beef freed from fat for a period of fourteen months. It must be observed, however, that the color of fresh meat thus treated changes speedily to the grey hue of boiled meat. He thinks, moreover, that salicylic acid is more useful as an addition to brine, than as a direct means of preserving meat.

Fresh butter mixed with a little of this substance (from one to two parts in one thousand), or covered with an aqueous solution of it, is preserved from three to five times as long as fresh butter not so treated. For the making of fruit preserves, and generally for the preservation of vegetables, is is also of great value.

For the preservation of wines and beer, as a preventive of their souring, Wagner agrees entirely with Neubauer as to the valuable qualities of this substance. Generally speaking, the addition of salicylic acid to any substances which undergo acetic fermentation (souring), retards the formation of the acid.

Wagner furthermore considers salicylic acid especially useful in tanning, in retarding the putrefaction of the skins, and in assisting the action of the bark and other tanning materials. In textile manufacture, it preserves the size that is used for a long time; similarly it retards for a month or two the decomposition of the paste used by bookbinders and others. In dyeing, it may be used for the production of violet color. It is a much more sensitive reagent for oxide of iron than sulphocyanide of potassium.—*Deutsche Industrie-Zeitung.*

MINING, METALLURGY.

The Future of Petroleum.—The *Iron Age* is of the opinion that the days of cheap oil are gone. In the years past, when the territory was not well defined, thousands of small operators drilled all over the country; and, as many were fortunate, and their necessities compelled them to sell, they were the means of keeping the oil down. Now, this is changed; the limits of the producing territory have been clearly defined by a cordon of dry holes or gas wells, and in the old territory the large strikes are things of the past. A few producers with large capital have bought up the heaviest producing territory, and are very conservative about sinking wells.

Dust Fuel in the Cupola.—Just as we are on the eve of going to press, our attention is called to certain extremely interesting metallurgical improvements, involving amongst other novel features, the employment of dust fuel in the operation of smelting iron in the cupola. The main features of these improvements have been secured by letters patent lately granted to William Batty, of Philadelphia, where the process has been in successful operation since last May. Concerning the results obtained in practice by this process we intend to speak fully in the future. We will remark in this place, simply, that we have witnessed the conversion of tin-scrap (clippings, old roofing, &c.) in a continuous operation, into good castings. The operators claim to be able to melt iron-waste of every description, and produce therefrom castings of any desired quality, by modifying certain details and varying the duration of the operation, the rapidity of which,—that is, the productive capacity of the cupola,—they claim to have doubled, while effecting a decided economy in the consumption of fuel. We regret that the crowded state of our columns, and the lateness of the hour at which this process was called to our attention, have prevented us from giving a full and detailed description of the same. This, however, will appear in our next. *

Iron Ores in Russia.—It is reported that immense and valuable deposits of iron ore have lately been discovered in the province of Ekatarinoslaw, in the valley of the Dneiper, in Southern Russia. The ores comprise hæmatites (red and brown) and magnetic, and are pronounced to be very free from both phosphorus and sulphur. One of these beds has the enormous thickness of 117 feet, and another 39 feet. The construction of a railroad and of iron furnaces for the utilization of these resources, is said to be contemplated.—*Revue Industrielle.*

Phosphor-Bronze Wire-Ropes.—The uses of this peculiar alloy appear to be extending rapidly in Europe, while in this country it is almost unknown. Its great strength and resistance to oxidation make it peculiarly well adapted, so far as these qualities are concerned, for many of our present applications of iron and steel. Certain practical difficulties appear to have been met with in working, rolling, and drawing this new product; the chief of which are, however, the inability of obtaining a perfect uniformity of quality, and of annealing uniformly. These difficulties it is affirmed, however, are rapidly disappearing. From a late report of the Phosphor-Bronze Company, of London, we learn that phosphor-bronze pit ropes are now used in Germany and Belgium, several of the highest mining authorities having recommended them on account of the great strength of the metal and its non-liability to rust.—*Engineering and Mining Journal.*

Tin in Montana.—The mineral exhibit of Montana at the Centennial will comprise, among other things, a number of specimens of lode and placer tin, and metal produced from the ore. The specimens are the contribution of Mr. H. M. Hill, of Clancy, Jefferson county. They are described as specimen from a mineral property that promises at some day to become exceeding valuable. It is affirmed that several mining districts in Montana contain tin ores in considerable quantity; but whether to an extent sufficient for profitable working remains yet to be shown.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

WAGNER FREE INSTITUTE OF SCIENCE.—At the regular monthly meeting, Saturday, March 11, the programme was as follows:

The report on Progress in Science and the Arts was read by Dr. William H. Wahl, Senior Secretary. He referred to the progress which had been made during the past month upon the jetty works at the mouth of the Mississippi River, a full description of which he had presented at a preceding meeting, and commented upon quite a number of engineering projects or enterprises already under way. He then gave a summary of the progress that had been made during the past year towards the solution of the problem of puddling by machinery, in which the relative merits of the Danks and Crampton system were specially dwelt upon; and a similar comparison between the rival merits of the Bessemer and Siemens-Martin processes of steel making; Mr. Gray's Electro-harmonic telegraph; a process for photographically recording spoken sounds, and several other technical matters of interest were also described and commented on.

The report of committee on Colbourn's Porous Evaporator was read.

A rubber diaphragm stated to have been in use for eighteen months in Walker's Non-Tamperable Safety Valve, was shown.

The following inventions were shown and described by the Mechanical Secretary, Mr. R. Grimshaw:

Simpson's trunk-closer and lock:

Rhind's safety lamp, which goes out if carelessly handled

French's piano truck, from Davenport, Iowa, enabling one man to take a piano up stairs.

McKiernan's steam whistle, from Paterson, N. J. In this the vibrating lip is a straight longitudinal cut in the periphery of a horizontal cylinder, the steam being introduced tangentially.

Gorringe's pivoted floating draw-bridge, from Washington. This can give an open water-way extending entirely across the stream.

Nystrom's steam boiler and hydro-carbon furnace, in which the products of combustion are mingled with the steam in driving the engine.

Shinn's rail-joint.

Upham's quick water-way, opening full with a half turn of the lever, and with greater ease than a plug-cock.

Powers' fire extinguisher and alarm, from Athol, Mass.

Some eggs prepared in October, by Wesley Wood, of Chester, and perfectly fresh when opened.

Morton's brass sash-chain and attachments, New York.

Heysinger's perpetual calendar.

Prentiss' iron paving-block, Northampton, Mass.

Randall's combined culinary apparatus, &c., Belvidere, N. J.

Edison's electrical pen and copying apparatus. A tiny electro-magnetic engine, mounted on the pen top, drives a needle through the paper some fifty-six times per second, thus making stencil lines of close perforations. From this stencil, by means of an inked roller, can be taken any number of single ink impressions.

ASSOCIATION OF ENGINEERING AND SHIP BUILDING DRAUGHTSMEN (Glasgow).—At the March meeting, Mr. Alexander Smith read a paper on "Water Tube Boilers;" showing room for improvement in these.

The inaugural address of Mr. N. P. Burgh, the President of the (British) Institution of Marine Engineers, is a gem; reminding one very forcibly of the highest flights of "The Oracle," in "The Innocents Abroad."

ST. LOUIS ACADEMY OF SCIENCES, *March* 6, 1876.

G. C. Broadhead read a paper on the meteor of December 9, 1875, which was seen at 9 o'clock P. M., over southern Iowa and northern Missouri. The duration of visibility was variously estimated at from three to sixty seconds. The majority of observers fix the time between three and ten seconds. At Kansas City, St. Joseph, Savannah, Oregon, Mound City, Graham and Maryville, an explosion was also heard, which was violent enough in many places to rattle windows.

Dr. Broadhead also remarked that T. Sterry Hunt has decided that the porphyritic rocks of south-eastern Missouri are Huronian. This opinion is based upon an examination of the mineralogical and lithological characters of the rocks.

Dr. George Engelmann made the following report upon the temperature of the past winter: After reporting about the unusually warm weather during every month of this winter, I have now, at the end of the three months, December, January and February, which constitute meteorologically the winter season, to state that the now past winter was, together with that of 1844 to '45 (thirty-one years ago), the warmest in forty years; namely a little over 40 degrees.

The coldest winters were those of 1855–56 and 1872–73, both about 14 degrees colder than the last, while the average winter temperature in St. Louis is about 33½ degrees.

Judge Holmes also read a paper on American antiquities. He remarked that he had long been impressed with the general similarity of the stone sculptures and pyramidal buildings of Palenque, Fopan and Uxmal, in Central America, with like remains in the Island of Java and other parts of south-eastern Asia—a genuine resemblance in respect of the stage of art and grade of civilization, rather than in the particular details or style. A like general resemblance with the earlier Egyptian monuments is also apparent, but much less striking in respect of the stage of progress, while in point of style and form in detail, the difference is so great that no inference of a common derivation could be thought of.

He referred to the fact that several other authors had recently made a similar observation, naming Mr. Hubert Bancroft and Dr. Samuel Ferguson. Mr. Bancroft infers that some of the ancient Central American cities were still inhabited when the Spaniards first arrived; but his facts hardly warrant such a conclusion. He admits, however, that Palenque had been previously abandoned. It is not easy to believe that the stage of art and progress indicated by these older remains of Central America existed, and was flourishing, contemporaneously with that found existing in Mexico and Peru, at the date of the Spanish conquest. There is no certain proof of the fact. And while the ascertained facts would seem to show a much more ancient date for these ruined, forest-covered cities, still their age may very well be quite modern in comparison with the vast period of time during which this continent has certainly been the seat of human habitation.

Mr. Nipher remarked that Mr. Stephens found the wooden lintels of doors at Uxmal, which seems to be conclusive evidence against a very great antiquity.

Mr. Conant exhibited the upper part of a skull from the New Madrid Mound, which was remarkable as having an exceeding low retreating forehead. The skull gave no evidence of abnormal distortion. It was found buried with the usual pieces of pottery which accompany the bones of the mound builder.

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, *March* 14, 1876.

Professor Haldeman called attention to his discovery, in a space twelve feet by ten, in an anticlinal axis near his residence, in the neighborhood of Chickies, of certain relics indicating the place to have been formerly inhabited by Indians. Two hundred pieces of pottery, 150 arrowheads, many flake knives, about a dozen chisels, bones, hatchets, &c., were found, some of them at a depth indicating an age of at least 2,000 years.

Professor B. Waterhouse Hawkins exhibited to the meeting two oil paintings executed as part of the decoration of the Princeton College Museum. There has been already finished for the museum by Professor Hawkins, a series of landscapes of the different geological periods, which have been warmly commended for the fidelity with which the probable conditions of vegetation, atmosphere, &c., of each era have been indicated. The pictures exhibited to the meeting of the Academy were designed to illustrate the later tertiary epoch, one of them being a representation of the fossil Elk of Ireland, and the other the Moa of New Zealand. Both of these animals, although now extinct, were contemporaneous with primeval man, and human figures are accordingly introduced to indicate this fact and at the same time to act as a standard of comparison of size.

Mr. Meehan spoke of the mode of propagation of the Florida Moss.

Professor Cope made some remarks upon a Cetacean which he had observed and described before the Academy ten years ago.

Mr. T. D. Rand described a specimen of phosphate of the sesquioxide of iron, which he presented to the museum.

Professor Frazer spoke of a peculiar trap from York county, Pa. The material is penetrated by a band of quartz which, except at the lines of contact, left the typical dolorite of the locality unchanged on each side. The vein of quartz cuts through all the older—and is not uncommon in the newer—rocks of the locality. The mineralogical significance of certain angular bodies observed in the quartz vein was dwelt upon.

Dr. Kœnig having been engaged upon the investigation of the minerals occurring at Magnet Cove, Arkansas, gave a preliminary notice of some of his results, reserving the details for a memoir which he hoped to place before the Academy at a future date. He described a garnet in which he had found an opaque nucleus upon making a microscopic section. It was therefore evident that these garnets cannot be of homogeneous structure. They make a precipitate in a neutral sulphuric acid solution, of a white flocculent substance, different from the usual form of titanic acid. It is probably an oxide of a new metal, although the investigation was not sufficiently advanced to enable him to describe its characters. He had found Vanadium in small quantities in all the minerals he had analyzed from the locality referred to, and the presence of this metal is very confusing in blow-pipe analyses, in consequence of the peculiar coloring it imparts to the flame.

Professor Hawkins stated that he was engaged in rebuilding the skeleton of *Hadrosaurus* in the museum, and gave a *resumé* of the dispute concerning the position of certain bones of the same.

Among the additions to the library announced was a superb volume of photographic illustrations of the Stone Age, of which twenty-five copies were published by the late Mrs. Caroline E. G. Peale, as a memorial of her husband, Franklin Peale.

A paper was presented for publication, entitled *On Pachnolite and Thomsenolite*, by George Aug. Kœnig, Ph. D.

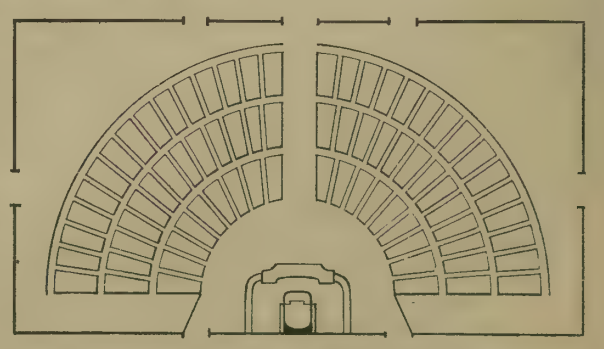
FRANKLIN INSTITUTE, Stated Meeting *March* 15.

Dr. Charles M. Cresson read a paper (illustrated by diagrams) by Mr. John E. Wootten, of Reading, on the use of pulverized fuel under steam boilers, especially referring to the successful use in a locomotive boiler of the dust from the immense heaps near the outlet of all anthracite mines. There was a closed ash-box; a jet of live steam is injected therein through a nozzle composed of two conical frustra jointed at their smaller bases, and furnished with a clack valve opening inward; the steam causes an air-blast, and the steam and air are forced through the fire-plate (which is pierced with holes tapering upward) and through three inches of fuel. The flame resembles that from bituminous coal. In the locomotive referred to, the exhaust, not being needed to aid the draft, is passed through a feed-water heater immediately behind the stack.

A stationary boiler of 100 H. P. was also in successful and economical operation, using the coal dust in the same manner.

There was exhibited an adjustable flag-staff holder, by Mr. Walter Hart; also Pfautz' "flying-bridge," extensible in length, and adjustable in the vertical and horizontal planes.

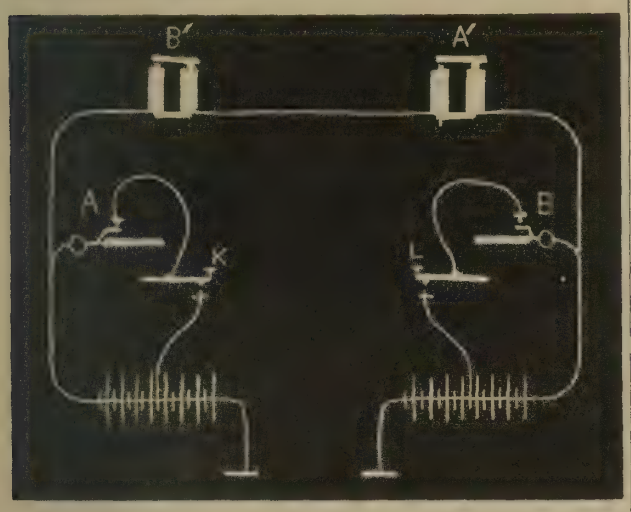
There was also described Joyce's improved mode of producing relief-plates for printing. A smooth steel plate is covered evenly with a thin coat of plaster of Paris and potter's clay; the design is then drawn through this (as through wax in etching) down to the plate. A stereotype-metal cast may be taken immediately from this reverse-plate, giving lines in relief. The more "open" the work, the greater the comparative cheapness of the process over other modes of producing relief-blocks. Herewith is given an impression from work done in this manner.



Mr. Elisha Gray then described the electro-harmonic system of telegraphy, by which musical tones, chords or tunes may be sent by telegraph, or any number of messages may be sent simultaneously on a single wire. The principle of operation may be thus briefly stated:

An iron rod elongates temporarily during magnetization. Successive currents produce successive elongations or vibrations, of equal rapidity, duration and interval. Musical tones

are caused by vibrations; the vibrations of a sounding reed may be made to make and break the electric circuit and cause similar and isochronous elongations of the receiving electro-magnet, the vibrations of the armature causing a musical tone corresponding to that of the vibrating reed, and capable of being "reinforced" by a sounding board. Reeds varying in tone being thrown into the circuit successively, the magnet and armature repeat their tones. To produce a musical chord, it is only necessary to have "receivers" on sounding boards, tuned in unison with, and equal in number to the transmitting reeds. The composite vibration being transmitted through the wire, each receiver and sounder selects and speaks to only that note with which it is tuned in unison. Thus, pressing the knob K throws the reed A into the circuit and into vibration; the receiver B′ takes no note of this vibration, which is responded to and reinforced by A′, tuned in unison therewith. Touching knob L transmits the vibration from B into circuit, and causes reinforced response from B′. Thus, complicated musical chords or any number of messages may be transmitted in either or both directions without interference or mistake. The vibrations of simple tones and melodies may also be received by placing the hand in connection with one pole and a metallic surface, as the bottom of an oil can, or the zinc lining of a bath tub, with the other. By rubbing the can with the finger (normally moist) the vibrations are made audible.



Melodies and harmonies were sent from Twelfth and Chestnut streets, and received on the lecture platform by the regular receivers and on the oil can.

This wonderful and interesting invention (or discovery) commanded the utmost attention and elicited inquiry and discussion.

CENTENNIAL NOTES.

Among the exhibits forwarded from London by the Secretary of State for India, is an exquisitely fine muslin, into which threads of gold are interwoven. This material is made in India exclusively for the Rajahs, and it is said that 50 yards of it can be doubled up and passed through a lady's finger-ring.

The buildings are in a more advanced state of completion and readiness to receive exhibitors, than those of the London, Paris or Vienna expositions. We regret that American exhibitors are so tardy in forwarding their exhibits.

Among the exhibits, we have space to notice the following:

In place and in use—

The Silsby Manufacturing Co., Seneca Falls, N. Y., has in place and in use in the Machinery Hall, a well built and handsomely finished straight-frame steam fire engine, with rotary engines and pumps of the Holly patent, and boiler of the construction shown by illustration in our continued article on Steam Fire Engines, page 26, current issue (which see). The pumps will be described and illustrated in our next number, in regular course. This engine was sent by request of the Commission for temporary protection of Machinery Hall, and is to be returned when the company's engines for exhibition (two to occupy space in Machinery Hall, and one to be placed in engine house of Centennial Fire Brigade), and which will be of the improved "crane-neck" pattern, are delivered. These "crane-neck" engines will be described in a subsequent issue in the articles on Steam Fire Engines referred to.

The Amoskeag Manufacturing Co., Manchester, N. H., has on exhibition and in use a "self-propelling" steam fire engine. This machine has a boiler 32″ diameter; two vertical steam cylinders, each 7⅝″ diameter, 8″ stroke; two vertical double-acting plunge pumps, each 4½″ diameter, 8″ stroke, with capacity of 900 gallons per minute. The frame is "crane-neck." The machine is propelled forwards or backwards by a connection between the crank-shaft and the rear wheels, made through an endless chain of ⅝ iron, working over sprocket wheels, with a set of compound bevel-gear upon the rear axle, so arranged that in turning the engine the two rear wheels are driven at varying speeds. The sprocket wheel upon the crank-shaft is 6″ diameter; that upon the axle, 30″. A key through the crank-shaft throws the chain gear in operation. The wheels are fitted with removable spiked tires. The tank contains sufficient water for a four-mile run. The throttle, variable exhaust and feed, are all operated from the foot-board. 50 lbs. steam pressure will run the engine for pumping or propelling purposes, although 80 lbs. is the usual working pressure. The machine weighs about 7300 lbs., being only 800 lbs. heavier than horse-drawn engines of the same pumping capacity, and is capable of running 16 miles per hour on good roads.

Royer Brothers. Hose-reels in place on pillars.

Blake Hose Co., Boston, New York and Philadelphia. 3600 feet of rubber-lined sewed and seamless canvas hose, from 2 to 7 ply, with Morse couplings.

Amoskeag Manufacturing Co., Manchester, N. H. Two-wheeled hose-reel.

C. Shanz. Hook and ladder truck.

Champion Fire Engine Co., N. Y. A No. 3 fire extinguisher.

Porter, Bell & Co. Shifting locomotive.

Aveling & Porter, Rochester, Eng. Locomotive road-engines and cranes.

Appleby & Co., London. Steam cranes, 2 of 5 H. P., 1 of 3 H. P.

In place, not arranged—

J. & G. Bolinder's M. W. A. B., Stockholm. Circular saws and appliances; Swedish stoves; flat-iron heater; school heater. There are vertical, reciprocating sawing machines, an edging saw, and a radial, swinging, cross-cut circular saw.

Major Adelskold. Car-axle boxes.

Arboga M. W. A. B. Remarkably fine chilled-iron car wheels.

1876. John Matthews, N. Y. Handsome "soda-water" charging apparatus.

J. E. Mitchell. A tasteful column of grindstones, on brick pedestal; mounted grindstones.

A. N. Wolf, Allentown. Turbine wheel.

1697. Ferris & Miles. Steam hammer, slide lathe, etc.

A. H. Marriner. Brass-punching machine.

1698. Pratt & Whitney, Hartford. Bolt, nut, screw and pipe thread-cutting machines, in great variety and fine finish.

82. Duncannon Iron Co. Nail machine, finely finished.

1718. Morris, Wheeler & Co. Spike machine.

3609. Baugh & Sons. Five bone mills.

1837. Three Rider compression engines.

S. C. Forsaith & Co., Manchester, N. H. Trip hammer.

Foundations were preparing for—

2771. Holyoke Manufacturing Co. Super calender and paper cutter.

Horizontal Engine. People's Works.

Automatic Engine Co.

Horizontal Engine. Hugo Bilgram.

853. Gasmotoren-fabrik Deutz (near Cologne). Langen & Otto gas motor.

P. Van den Kerchove, Gand, Belgium. Coupled Corliss horizontal engines of 175 and 135 H. P. 15 H. P. Rider engine.

Bullock Press.

Hoe Press.

Exhibits on hand not in process of erection, etc.—

1280. Blake Crusher.

1650. George F. Blake Manufacturing Co., N. Y. Pumps.

1920. Lovegrove & Co. Whitmore engine, 10 H. P.

6777. Hampson, Whitehill & Co. Portable and Semi-portable engines.

1756. W. E. Kelly, New Brunswick. Sectional boiler.

E. Green & Son, Wakefield, Eng. Sectional boiler.

Abendroth, Root & Co., New York. Sectional boiler.

5027. C. A. & W. L. Teal. Iron plate cutting and bending machines.

The following exhibits are in process of erection—

Taylor's Hydraulic Cotton Press.

I. P. Morris & Co. Vertical column, compound blowing engine: high pressure steam cylinder, 50″ diameter; blowing cylinder, 90″; stroke, 84″. Fitted with Wanock's balanced valve. To run 16 revolutions per minute. Height above floor, 38 feet; fly-wheels, 24 feet diameter, weighing 21 tons each; weight, 119 tons. The blower piston has maple sectional rings, which can be set out; the valves are griddles.

B. & S. Massey, Manchester, Eng. Eight steam hammers, from ½ to 50 cwt.

Circular iron cutting saw, 30″ diameter, to make 1200 revolutions.

Baltimore Pearl Hominy Co. Pearl hominy mill.

E. V. Machette, Jr. King flouring mill.

107. Allison & Bannan. Twin double-acting horizontal blowing engine.

Mirrlees, Tait & Watson, Glasgow. Very large cane-crushing machine, driven by a vertical compound beam engine, of the parallel motion order; high pressure cylinder, 24×54, 35 H. P.; Corliss valves.

Valère Mabille, Mariemont, Belgium. Chaudron's patent steam hammer; cage for mine hoists.

National Rubber Co., Providence. Complete rubber factory, with set of 3-ton calender rolls, etc. This factory will employ about 75 horse-power.

Fairbanks & Ewing. Scales of every description and size.

MISCELLANEOUS.

Weighing a Beam of Light.—Prof. Crookes, F. R. S., has performed before a distinguished audience, at the Royal Institution, the much discussed achievement of "weighing a beam of light."

Desiring to weigh some small quantities without the disturbances inseparable from the ordinary operation, the lecturer made arrangements to weigh in a vacuum, but was surprised to find that he had apparently called into existence another set of no less embarrassing disturbing causes—since the approach of a light to the exhausted vessel appeared to modify the action of gravitation. Prof. Crookes at once set to work to determine the general conditions and intensity of this disturbance, and his investigations culminated in the lecture now mentioned, where he weighed the pressure from the light of a standard candle 6 inches off, falling upon a surface of 2 square inches *in vacuo*.

It was at first thought that this force of light must be inconceivably small; so there was constructed a horizontal pendulum, so extremely sensitive, that "by changing your position in a room you altered the centre of gravity of the whole house, and so threw out the readings of the instrument!"

The horizontal pendulum was then incapacitated from *trop de zéle*, and a suitable substitute found in the torsion balance—a flat index of pith hung by a cocoon fibre. When one-half of each index face was blacked on alternate ends, and the apparatus placed in the light, rotation commenced, and continued until the torsion of the fibre caused a retrograding. The step from this to continuous rotation placed the world in possession of the far-famed "radiometer."

In its simplest form this has two cross-arms, carrying at their ends four pith disks, blackened on one side, delicately balanced on a vertical pivot, and enclosed in a thoroughly exhausted glass vessel. The rotation is projected on a screen. When the heat rays of the electric light were cut off by an alum solution, rotation still continued, but at a decreased velocity.

The ultra-red were found the most powerful of the spectral rays—not surprising when we remember that the emission of heat from these is nearly 8 times the entire luminous emission. The dynamic force of the ultra-red rays being 100; that of the violet is 5 only.

The relatively small effect of the interposition of colored glass on the rotation speed, was shown by a radiometer having a central mirror, causing a dot of light to describe a circle on the ceiling. At first great lightness in construction was deemed necessary; but here we have a mirror carried, and if a mirror, why not a magnet?

Prof. C. suggests this as a mode of recording the amount of light enjoyed by any vicinity throughout the year. To obtain power, augment the number of pith disks, and record each revolution by a Morse instrument, through the agency of a magnetic arm of the radiometer, and a little magnetic needle outside the glass vacuum chamber, which needle bows to the arm as it passes and so establishes and breaks contact.

Prof. C. also suggests the radiometer as a means of testing illuminating gas. The standard candle is very variable, and Prof. C. would shift the position of the candle until the dot of light from his mirror fell upon a given point in the scale. Opposing to this candle the gas-flame, and adjusting it until the dot removed to zero, the illuminating power of the gas in question, in *true* standard candles, would be at once deducible by squaring the distances. For instance, one candle at 12 inches balanced two candles at 17 inches—the square of the latter distance (289) being double that of the former (144).

The concluding experiment was weighing the pressure of a beam of light from a standard candle 6 inches distant upon an area of 2 square inches. As the correctness of the result was dependent upon the perfect elasticity of a fibre of *glass*, this

material was tested for elasticity and strength by twisting one fibre completely round 20 times, and by loading another with nearly 1,000 grains of lead.

The apparatus for weighing the beam was an exhausted glass chamber, in the form of a horizontal cross, with arms of circular cross-section. Inside the larger arm was a glass fibre kept at uniform tension by a spiral spring at one end, and a glass stopper at the other end, which stopper was capable of rotation, being lubricated with an air-tight preparation of melted india rubber. The shorter arm of the cross contained in like manner a stouter fibre or beam of glass, secured at the point of crossing to the longitudinal or torsion fibre, and having at one extremity the pith surface of 2 square inches area, and at the other a little cup. Inside the chamber there was a loose particle of iron weighing $\frac{1}{100}$ grain, and outside the stopper was a counter to record the number of turns given at any time to the torsion-fibre.

The mode of procedure was as follows:

The position of the dot of light from the little mirror at the intersection of the glass-fibres first noted and called "zero." The grain of iron was first lifted by a magnet and deposited in the cup at the end of the cross-beam, lowering the beam at once. Torsion was then applied to the glass-fibre until the beam lifted and the dot of light returned to zero. On this occasion 10,021° of torsion (rather more than 28 turns) were needed. The weight and torsion were then removed, the ray of light was caused to fall upon the disk, and caused a depression requiring 1628° of torsion to overcome; hence 10,021° : 1628° : : .01 grain to .00162 grain, the pressure of the light falling upon the surface of 2 square inches.

In a more deliberately conducted experiment the pressure was found to be .001772 = about $\frac{1}{8}$ (.128) grain on the square foot. Since the candle was 6 inches distant, the sphere of which the candle was the centre was 1 foot in diameter; hence the total pressure radiated by the candle = $.128\,\pi$ = .402 grains.

The lecturer assumed that ordinary sunlight equals 250 candles at 6 inches distant; then the pressure per square foot upon the earth's surface from the sun's radiation would equal $250 \times .128 = 32$ grains, or say 57 tons per square mile.

This is an enormous statical force, and it is of the greatest moment that its dynamical equivalent should be approximated to in an equally accurate manner.

How far would this statical pressure be maintained upon a body retreating before a ray of light?

It might be assumed that the velocity of a retreating body would be as nothing compared to that of light, and that hence the pressure upon the disk would remain constant. This could hardly be so, else we should have a force of unprecedented magnitude.

Capt. Ericsson has found that the average radiant heat of the sun during nine hours of each day equals $3\frac{1}{2}$ units of heat per square foot per minute, or say 45 foot pounds, or 315,000 foot grains per second. Dividing this by Mr. Crookes 32 grains, we have a velocity of about 10,000 feet per second; that is to say, if the pressure of sunlight upon a resting body is the same as in a body retreating 10,000 feet per second, or but $\frac{1}{100000}$th the velocity of light, the dynamic force developed would be equal to the whole potential energy of the sun's radiant heat. Further, the efficiency of Ericsson's caloric engine being .10, it follows that were the 32 grain pressure maintained even up to 1,000 feet per second, or one millionth the velocity of light, the proportion of heat, or light, or whatever we call that mysterious service of power which Mr. Crookes sometimes terms "a function of the refrangibility," converted into power would be the same in the radiometer as in Ericsson's engine.

It would be interesting to determine the actual work done in turning the radiometer at different velocities, or to compare the weight of the sun's radiated light at different hours and seasons in order to ascertain if the proper motion of the earth's surface at all affects the pressure.

Referring for a moment to the candle experiment, we know that the total heat of combustion of a standard candle is 5.5 units per minute. Ericsson tells us that a square foot of sunlight is 3.5 units. Mr. Crookes again estimates sunlight as equal to 250 candles 6 inches distant; whereas, if each unit of the candle heat were equal to a unit of heat from the sun, but two candles would be required, since $\frac{3{\cdot}5}{5{\cdot}5}\,\pi = 2$. The inference apparently is that of the total heat of combustion of the candle less than one per cent. is radiant heat or light of which the radiometer takes cognizance.—[From *Engineering*, February 18.]

The Controversy Respecting Spontaneous Generation.—Professor Tyndall has recently brought before the Royal Society, the results of a new and ingenious series of experiments bearing upon the vexed questions of spontaneous generation—a question which, despite the researches of Pasteur and Schroeder, and their numerous followers on the one hand, and the arguments of Bastian and the dogmatism of Haeckel on the other, is still far from a satisfactory settlement. The great difficulty in the discussion of the problem has lain in the unaccountable contradiction of the disputants on either side, who claim to have obtained diametrically opposite conclusions under apparently identical conditions; each party in turn repeating every fresh experiment devised by the other, and finding therein confirmation of its own views. A striking instance of this discrepancy of observation is given in Tyndall's paper. Not long ago Dr. Bastian announced that if an infusion of animal tissue be boiled in a glass vessel, the mouth of which is hermetically sealed during ebullition, and kept in a warm place, "after a variable time the previously heated fluid within the hermetically sealed flasks swarms more or less plentifully with bacteria and allied organisms." Acting on this statement, Professor Tyndall prepared in the manner specified, one hundred and thirty-nine flasks, containing various infusions of fish, flesh and fowl, and out of all these, not one showed any evidence of implanted life. So, too, with infusions exposed to air filtered through cotton, wool, or to calcined air, or preserved *in vacuo*, in all of which living organisms were found by Bastian, in none by Tyndall. To account for such differences, it has been easy for one set of disputants to allege that where organisms are found, their infinitesimally minute germs must have been admitted through carelessness in manipulation, whilst the opposing faction have insisted that in the negative experiments the air or the infusion was not merely secluded from the entrance of foreign germs, but in some way deprived of its capacity to support life.

To eliminate these sources of uncertainty, Professor Tyndall has operated with air, absolutely "untortured" by any artificial process, and containing the usual amount of aqueous vapor and other gaseous matters, purified only by the natural settling of the suspended organic particles. His apparatus consisted of a box with a glass front, and panes of glass facing each other at the sides, so that it could be perceived when the inclosed air no longer showed floating motes in a transmitted beam of bright light. The interior of the box was smeared with glycerine to entrap the settling particles, and from the top two bent tubes were open to the outer atmosphere. At the bottom were placed test tubes to contain the fluids under observation, so arranged that they could be filled by means of a long glass tube from the top. The purpose of this apparatus, it will be perceived, was simply to shield the contained air from disturbance without in any way altering its constitution. At first a concentrated beam of light passed through the box, had its track made visible by floating matter, but after three days of quiet, the interior air was moteless to the transmitted ray. The test-tubes were then filled with various infusions of vegetable and animal substances, boiled for five minutes, and abandoned to their fate. The result of numerous experiments was that whilst similar infusions in the outer atmosphere invariably putrefied and swarmed with organisms in from two to four days, not one of them kept in the moteless air of the box showed any sign of putrefaction or bacterial life; yet, after thus remaining unaltered for four months, the opening of a little trap-door to admit freely the external mote-laden air caused an abundant production of bacteria in three days. These investigations seem fully to justify the author's inference, that even the lowest forms of vegetable life can only arise from implanted ultra-microscopic germs, and at all events throw a new burden of proof upon the upholders of abiogenesis.

A further series of experiments to test the atmospheric diffusions of germs led to some exceedingly suggestive deductions with regard to the spread of epidemic contagia. A tray holding one hundred test-tubes, thirty of which contained an infusion of hay, thirty-five an infusion of turnips, and thirty-five an infusion of beef, being freely exposed to the atmosphere, it was noted that the different tubes were attacked by putrefaction at different times and in different degrees. One tube of the beef group was first invaded, and became turbid a day in advance of any of the rest; a single one of the hay group showed muddiness, while its immediate neighbors remained clear; four of the turnip group, separated from each other by considerable intervals, were involved several hours before their fellows; and so on successively until all the tubes were affected. Even then, of tubes containing the same infusion, in some bacteria preponderated and showed great activity, whilst in others they moved feebly and were overpowered by a fungus known as *penicillium*. From these and other phenomena, Professor Tyndall concludes that the bacterial germs float through the atmosphere in small clouds, with sparsely occupied spaces between them, and he further opines that the germs differ among themselves in respect of fitness for development, some being fresh, others old, in different conditions of dryness or moisture, and in this way he accounts for the successive outbreaks of epidemic disease, and the varying periods of latency and greater or less degree of severity of the malady in different individuals.

Although it may seem that the above cited experiments fully complement and corroborate Professor Tyndall's earlier affirmation, concerning "dust and disease," it is but fair to add that Dr. Bastian is still unconvinced, and proposes to his opponent "to take his own boxes, to use all the precautions he specifies, and yet by careful attention to the preparation of the infusions and to the degree of heat to which they are exposed subsequent to boiling, to show him and others that some of the fluids which in his hands have hitherto invariably remained barren, may yet be made to swarm with bacteria."

The question of spontaneous generation, aside from its philosophical aspect, is of great practical importance to the public in connection with the prevention of infectious disease, and we await with some anxiety the new affirmative evidence which Dr. Bastian promises to soon lay before the Royal Society.—*New York World.*

International Coinage.—Dr. Barnard, President of the American Metrological Society, has addressed a memorial to Congress advocating the preparation of coins of metrical weight and uniform fineness (9-10ths), and the securing of legislation and treaty stipulations by which such coins shall become legal tender, according to their weight. The unit of this coinage, says the *Engineering and Mining Journal*, would be the gramme of standard gold, and a 10-gramme piece would be worth a little over $5.98, or 24s. 6.984d. sterling, or 29.052 francs, or 25.234 marks, or 8.411 Prussian thalers. It would practically circulate as $6, or 1£ 4s. 7d., or 29 francs 1 sou, or 25¼ marks, or 8 Thr. 12 silber-groschen. In relation to this proposition, Dr. Barnard has remarked: "Let the new coins be issued without any other denominational stamp than their weight in grammes, the reverse being distinguished by any suitable device of general significancy, and there can be but little doubt that they would soon be received with favor, and employed in local transactions interchangeably with those of the local coinage."

A Steam Feeding Apparatus is on hand in Philadelphia, in model form. The design of this apparatus is to enable one hundred persons, instead of wasting eight or ten minutes apiece at dinner, to fill themselves to repletion in less than five. It is not promotive of sociability, to be sure, but it saves time and servants' wages. We would suggest, as a companion, a belt with a dial plate, indicating just how full the diners become; they to be charged accordingly.

The Vestal Flame has a rival in the fire lighted 51 years ago by the New York Gas-Light Company, and never yet allowed to go out. In 1874, when the works were moved from Canal and Centre streets, the burning coals were transported to the present location, Twenty-first street, East River.

Death Rate in Cities.—In Madrid, the annual death rate per 1,000 is 65; Vienna, 32.7; Berlin, 30.6; Rome, 29.3; New York, 27.9; Turin, 24.8; Brussels, 24.8; Paris, 23.2; London, 22.2; Philadelphia, 20.3.

BIBLIOGRAPHICAL NOTICES.

BENNER'S PROPHECIES OF FUTURE UPS AND DOWNS IN PRICES. WHAT YEARS TO MAKE MONEY ON PIG IRON, HOGS, CORN AND PROVISIONS. By Samuel Benner, an Ohio Farmer. 16 mo., 131 pp. Cincinnati: Published by the Author. 1876. Price $1,00.

This is a curious and instructive little book, written in a practical and attractive manner, and evidently based upon careful study of prices and production in the past, the "predictions" of future prices and panics. The author claims that there is a "cast-iron rule," that "one extreme invariably follows another" in history and harvests, prices, productions and panics.

From statistical records since 1834 he announces that in Pig-Iron the cycles of advances are as follows, in terms of years: 3, 2, 4; the declines being 6, 5, 7. At the bottom of the scale are shown the lowest priced years, 1834, '43, '50, '61, '70; and in the future, 1877, '88 and '97. At the top are the highest priced years, 1837, '45, '54, '64 and '72; and in the future, 1881, '91, '99. Mr. B. predicts that the daily price in 1877 will run below $20 per ton; and in 1881 above $50.

Concerning the Hay crop, the years of lowest price are noted as 1850, '55, '61, '66, '72, '77, '83 and '88; the maximum prices being for 1836, '47, '53, '58, '64, '69, '75, '80, '86 and '91; the intervals between the minima being 5, 6; 5, 6; and the maxima being 11 years apart.

"The same scale of prices for hogs will answer for corn," the cycles being the same.

The table of cotton prices since 1821 indicates 11 year cycles in both rise and fall. 1880 and 1991 are indicated as "high price" years in cotton; in the latter, cotton, corn, hogs and pig-iron being together at a maximum price, and general business predicted as prosperous up to that year.

The Cycles in Panics from 1803 are given as 16, 18, 20; 16, 18, 20; making 54 years as the "grand cycle." The next panic is announced for 1891; 1876 and 1877 to be years of great depression in general business, coming at the end of the five years' decline in the price of pig-iron.

Whether or not the lessons of the past cycles warrant us in accepting the predictions given, they are well worthy our intelligent study and consideration.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. I. PHILADELPHIA, MAY, 1876. NO. 4.

[OFFICIAL.]

THE NEW PUBLIC BUILDINGS, PHILADELPHIA.

Ground was first broken for the erection of this mammoth structure on the 16th of August, 1871, by John Rice, Esq., then President of the Board of Commissioners, though probably the removing of the iron railings, which enclosed the four squares at Broad and Market streets, on the 27th of January, 1871, may be considered as the actual beginning of the work. At 2 o'clock P. M. on the 12th day of August, 1872, the first stone of the foundations was laid, and on the 4th of July, 1874, the corner stone proper was set in place.

The principal dimensions of this vast building are ar follows:

It is 425 feet square, exclusive of all projections, and is the largest building in this country; exceeding in area the Capitol at Washington by considerably over 20,000 square feet.

To the top of the figure of William Penn, surmounting the dome of the tower, from the pavement, measures 510 feet, which is the highest architectural point ever reached by man. Strasbourg Cathedral reaches 486 feet; Cathedral at Milan, 438 feet; at Utrecht, 464 feet; at Antwerp, 476 feet; Capitol at Washington, 287 feet 6 inches, and the Pyramid of Cheops is supposed to have been at one time nearly 500 feet high.

The sub-basement is 11 feet in the clear; basement, 18 feet 7 inches; first floor, 31 feet 8 inches; second floor, 30 feet 2 inches, and the two stories in the roof average 20 feet. These heights are again subdivided in the court yard, making six stories besides the basement. The centre pavilion on each of the four fronts to the apex of the roof, 210 feet, which is but 15 feet less than the highest point of the tower on the Masonic Temple at Broad and Filbert streets. To the apex of the roofs of the corner pavilions 170 feet.

Two magnificent corridors run through the building for the accommodation of pedestrians going north or south or east or west. The south, east and west corridors are 15 feet 10 inches wide, while the northern one measures 18 feet 3 inches in breadth.

THE NEW PUBLIC BUILDINGS, PHILADELPHIA.

Each of corner pavilions contains a stairway of 10 feet width, connecting with all principal and intermediate floors. There will be a stairway 9 feet wide in the southern centre pavilion, connecting with all the floors, the treads of the steps being 13 inches with risers of 7 inches. In the Mayor's or eastern entrance is a stairway 10 feet wide, leading from the ground floor to the first or principal floor. In the northern or council entrance is a stairway of the same breadth, leading to the Council Chambers; also the Council Conversation Hall, from which a circular stairway leads to the second story of tower and to the Governor's Reception Room. On the north corridor of the first floor, on either side of the centre pavilion two fine stairways of 7 feet breadth lead to the galleries of their respective Council Chambers. In addition there are numberless stairways of smaller dimensions, and four elevators in the corners of the building furnish another method of transportation from the sub-basement to the roof.

There are over 525 divisions or compartments in the building, all of them perfectly lighted, heated and ventilated, and absolutely fireproof.

That an intelligent idea may be formed of the magnitude of this work, a brief statement of the aggregate amount of material used in its construction up to January 1, 1876, will be found of interest.

The excavation for the cellars and foundations required the removal of 141,500 cubic yards of earth. Of concrete, 74,000 cublic feet has been laid; 636,400 cubic feet of foundation stone; 22,737,025 bricks; 135,334 cubic feet of marble; 3,317,761 pounds of wrought and rolled iron; 377,667 pounds of cast iron; 23,708 cubic feet of buff sandstone; 188,020 cubic feet of granite; 3,025 cubic feet of polished granite; 15,239 superficial feet of slate; 3,281 barrels of cement, and 945,721 feet of lumber.

The foundations of the immense tower are laid on a bed of solid concrete, 8 feet thick, at a depth of 20 feet below the surface of the ground, and its walls, which at the base are 22 feet thick, are built of stones weighing two to five tons each. Many of the granite blocks in the basement are upwards of 10 tons in weight; but even this enormous weight is over-topped by a huge granite slab, lately placed in the tower, whose weight is 33 tons, being the heaviest stone by many tons ever brought into Philadelphia.

This building covers, exclusive of the court-yard in the centre, an area of nearly four and one-half acres, and the style of architecture in which it is built is known by the generic term of "Renaissance." The statue of William Penn crowning the summit of the tower will be 35 feet in height, and be cast in bronze or wrought in stone, and the total amount of money expended thus far in the construction, including the relaying of the tracks of the West Philadelphia Railway, and the changing of the water and gas mains has amounted to $3,003,418.74.

The officers and members of the Commission for the erection of the New Public Buildings are:

President—Samuel C. Perkins.
Secretary—Francis De Haes Janvier.
Treasurer—Peter A. B. Widener.
Solicitor—Charles H. T. Collis.
Architect—John McArthur, Jr.
Superintendent—William C. McPherson.

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ARCHITECT'S ASSISTANTS.

Thomas U. Walter, Washington B. Powell, Jesse L. Ferguson and Grayson P. McArthur.

MODERN FIRE ENGINES.

IV.

PUMPS.

The requirements of Steam Fire Engine Pumps are many and severe. They must be light and strong; brackish water must not corrode, muddy water clog, nor grit cut them or affect their lifting capacity. They must require no packing save what can be done rapidly or even while running. They must draft water, without "priming," from any depth up to 28 feet; and force it, after passing through from 50 to 1000 feet of hose, in a steady, solid stream to a distance of at least 150 or 200 feet. The suction-hose (which is a part of the pump, made flexible for convenience) should be of diameter equal to or greater than the pump-barrel, in order that the latter may readily obtain a full supply of water. The stroke must not be so rapid as to run away from the incoming water, or to prevent the valves from seating properly. The suction inlet and valves, which receive water at a low pressure, should be larger than the pump area, and the discharge-valves

through which the water is to pass at a high pressure and speed. The suction and discharge chambers should be of sufficient capacity to steady and equalize the supply and discharge of water. All valves and parts should be readily and quickly accessible or removable. If possible to attain steadiness with a single pump, it is to be preferred to two or more of the same united capacity—as being lighter and more compact, and having less friction and fewer glands than two. If reciprocating, it should be double-acting for purposes of steadiness and economy. It must not require to be run at such a high rate of speed as to cause heating or rapid wear of bearing surfaces, or excessive consumption of lubricating oil. As far as possible, all parts should be capable of reduplication by telegraphic order sent to the works, or of manufacture and application by any skilful mechanic with suitable facilities. There should be a "churn" valve to permit of pumping up when there is no need of a fire-stream; and a relief valve proper to enable any pipeman to control his own fire-stream without affecting that of his neighbor, or calling upon the engineer to effect the desired change. There should be no local or side wear of piston or cylinder. The pump must not impart motion to the whole machine, as all jumping, rocking or rolling of the apparatus racks the machinery, lessens the power, wears the hose, and unsteadies the stream.

Great as is the difference of opinion concerning the relative merits of "coil," "water-tube" or "smoke-flue" boilers, the rivalry in pumps exceeds it. The question of "rotary" or "reciprocating" has not yet been satisfactorily solved; while among the many styles of reciprocating pumps, rival builders and their customers argue fiercely the points *pro* and *con* of vertical or horizontal, long stroke or short, single or double acting, simplex or duplex cylinders, hinge or poppet, metal or rubber valves, &c.

The question of rotary engine and pump *versus* reciprocating, is the most widely and sharply discussed. The writer inclines to the belief that, theoretically, the rotary may be made the most efficient; but unquestionably there have been few rotary engines or pumps that have approached even nearly the performances of the reciprocating. Of these few, the Holly, used by the Silsby Manufacturing Co., is the most satisfactory known to the writer; and it certainly has demonstrated, by years of service, that the rotary principle *can* be applied to do steady, powerful work, with little wear and tear. Its greatest disadvantages are the high rate of piston velocity, and, with the engine, the inability to use the steam expansively. The makers, however, claim that the lack of valves and the absence of "jerking" compensate for these disadvantages, and that economy results in the use of the rotary. It is certain that the Holly is the only rotary that has stood the test of extended use and popular approval—and it is a great step onward.

Fig. 17—THE SILSBY (OR HOLLY) ENGINE AND OLD PUMP.

The construction is shown in Fig. 17, which gives an end view. The steam enters at A, and passes out at B, turning the two revolvers *c* and *d*, in its passage. The sides of these revolvers are packed, as shown, by blocks of metal inserted in grooves in the long cogs, and kept out by the momentum of the cams, assisted by springs. The *ends* of the revolvers are ground to the ends of the cylinders in which they turn. The pump is precisely like the engine; the revolvers being carried around by gears on the outside of the cylinder, to save wear. The revolution of the cams draws the water in at A, as shown by the arrows, again converging the advancing streams at the discharge B. The same principle is applied in the rotary blower of Roots.

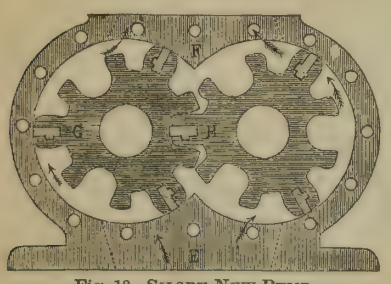


Fig. 18—SILSBY NEW PUMP.

As recently improved, the pump is made with three "toes" on each revolver, resulting in greater steadiness of stream. Fig. 18 shows this improvement.

Fig. 19 shows the position of the pumps, &c., on a Silsby engine of the most recently improved pattern. The suction-hose is shown attached.

The second-class Silsby engine pump "cylinder" (or chamber) is of cast iron, with steel shafts and bronze boxes. The speed of piston is 11½ feet per second, or 690 feet per minute. (We must, however, remember that this is a continuous or revolving motion, and a much greater speed is attainable with safety and steadiness than where the motion is reciprocating, requiring the inertia to be overcome at the end of the stroke.) There is one suction-inlet, area 15.9 square inches, and two discharge outlets, with a united area of 9.8 square inches. The air-chamber holds 12 gallons, or 2772 cubic inches; the vacuum-chamber contains 3 gallons, or 693 cubic inches.

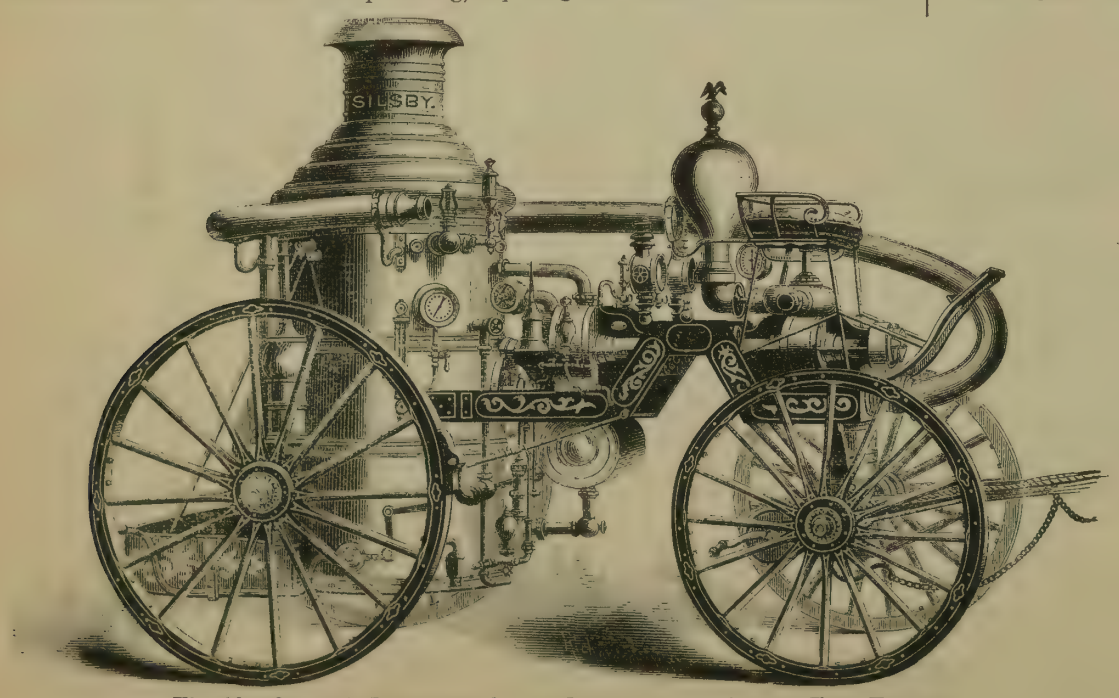


Fig. 19.—SILSBY'S IMPROVED CRANE-NECK ROTARY STEAM FIRE ENGINE. CENTENNIAL EXHIBIT.

The makers of a rotary apparatus recently introduced, and claiming great superiority, will give no information concerning its structure and operation, and as the writer can find none in use as yet, full description must be deferred. The principal improvement claimed over the Silsby pump, is an "adjustable packing-plate" at the ends of the revolvers.

Among "piston" or reciprocating engines, the most widely known is the "Amoskeag," of Manchester, N. H. The working parts of this machine are difficult of access, but the principle of duplication of parts is so perfectly carried out, in connection with compactness and good work, that there is no engine possessing a higher reputation for "wear and tear" and general resistance to abuse.

THE AMOSKEAG PUMP.

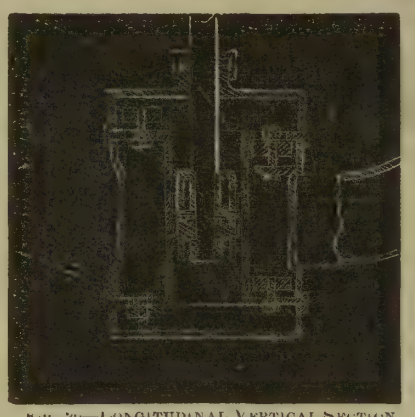


Fig. 20—LONGITUDINAL VERTICAL SECTION

Fig. 21—TRANSVERSE HORIZONTAL SECTION, through centre of pump. K, suction-valves; P, discharge-valves; S, pump-barrel.

The pump is short stroke, of the double-acting, plunger pattern. The pump-barrel proper (S) is surrounded by a concentric cylindrical shell, divided longitudinally into halves by partitions, so as to form the suction and discharge chambers. There is a separate valve-plate at the top and bottom of the pump, each carrying four suction and four discharge-valves—the suction-valves on one side, and the discharge on the other. At each upward and each downward stroke water passes four suction and four discharge valves of each pump. The valves are rubber poppets, circularly disposed in the inner heads of the shell, and are reached by removing the outer pump-heads.

Fig. 22.—AMOSKEAG FIRST-CLASS SELF-PROPELLING CRANE-NECK STEAM FIRE ENGINE. CENTENNIAL EXHIBIT.

Since first manufactured the stroke of these pumps has gradually been shortened, with proportionate increase of piston speed.

In the second-class engine there are two vertical pumps, each 4¼″ diameter, 8″ stroke, being of cast iron, with brass lining. The piston is cast iron, with leather cup packing, and travels 4.44 feet per second in ordinary working duty. Each pump has one suction inlet, which answers for both pumps. There are on each pump eight suction-valves, with a united area of 20.8 square inches, and eight discharge-valves, whose united area is also 20.8 square inches. There are two outlets, with a united area of 9.8 square inches. The suction-chamber has a capacity of 675 cubic inches; the discharge air-chamber holds 4400 cubic inches.

The accompanying engraving (Fig. 22) shows the disposition of the pumps and air-chamber in an Amoskeag double engine. The suction-hose is detached and removed.

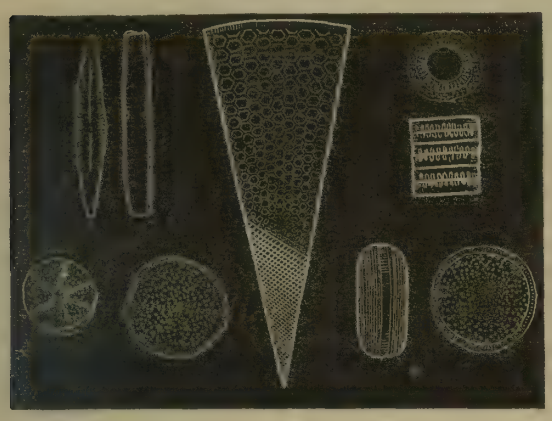
[*To be Continued.*]

FIRE PROTECTION.—The present number of our journal contains the fourth illustrated paper on Steam Fire Engines. From time to time we shall publish illustrated papers, already prepared, upon Fire Extinguishers, Extension Ladders, Hydraulic Hose, Hose Couplings and Attachments, the Fire Alarm Telegraph, Fire Proof Construction, &c., embracing, in fact, the entire subject of Fire Protection.

INFUSORIAL EARTH AND ITS USES.

II.

Concerning the applications of this curious substance in the useful arts, quite a chapter might be written. During the past few years it has attracted the special attention of practical men, and so many and various have been the uses for which it has been suggested, that their bare enumeration may well excite surprise. At least one very important industry of recent origin has been practically created by it, and its employment in others is steadily growing in extent and importance. A summary of the subject in its technical aspects, with brief comments upon the more important items, is given in what follows.



The most popularly known and perhaps the earliest application of the diatomaceous earth, is its utilization as a polishing agent for stone and metals. For this purpose, when carefully freed from grit and other impurities, its considerable hardness, and its wonderfully fine state of division, fit it most admirably. It may be applied wet or dry. It is well known in this connection under the name of tripoli, so called from the locality whence it was originally brought. Under the name of "electro-silicon," "magic-brilliant," and other trade designations, the diatomaceous earth from Nevada and other localities has been extensively introduced as a polish for gold, silver and plated ware, for which, as for tin, britannia ware, and other metals used in the household, its wide popularity is the best proof of its excellence.

Being a very poor conductor of heat, it has been suggested and applied for surrounding ice, beer and ale cellars, fire-proof safes, steam-boilers, powder-magazines, refrigerators, &c. The results of certain experiments lately made by Refardt & Co., of Braunschweig, to ascertain how this material compared with other substances generally employed for the purpose, are highly favorable to the merits of infusorial earth for this application.

Without entering into the mechanical details of the apparatus employed in these trials, it will suffice to state that in the time required to melt one hundred parts (by weight) of ice surrounded by the silicious earth, two hundred and thirty-five parts of ice were melted in a cylinder surrounded with an equally thick layer of dry, light garden earth. Moist earth, and moist materials generally, gave still more unfavorable results. Again, for every one hundred parts of ice melted when protected by the infusorial earth, one hundred and forty-two parts of ice protected by dry, sifted coal ashes, were melted. The results obtained with flax-shives were about the same as with the infusorial earth. These trials demonstrated that infusorial silica and flax-shives offer the greatest amount of resistance to the transmission of heat; that dry coal ashes are far less efficient, and moist ashes still more so; and finally, that earth, as compared with these, is very inferior as a non-conductor. The use of the infusorial earth is therefore hightly recommended for filling in between the walls, and for covering the mason work in ice-cellars. For this purpose the following additional advantages are urged in favor of this substance, viz.: It is extremely light—being nearly five times as light as dry earth, and about twice as light as dry coal ashes, and it is not combustible, remaining unaffected in the hottest fire. These properties, to quote from the published account of the above trials, render this substance preferable to flax-shives, tan-bark, peat, saw-dust, and similar materials, which are about equal to it in non-conducting quality, but which are combustible, and when kept for some time rot or moulder, shrink and settle, and might, under some circumstances, take fire spontaneously (*sic!*).

The infusorial earth, it is further claimed, will be found highly useful in fire-proof safes, as a surrounding for powder magazines on shipboard, for covering steam-pipes and boilers, and for all similar purposes. Reference is made in some of the encyclopædias (*vide* American Encyclopædia, III, 268) to what are termed floating bricks, which, according to account, are made of infusorial earth, and are named in virtue of their power of floating upon water. Clay is sometimes added to the silica to assist in binding the material together. Such bricks, we are told, were made in ancient times, and were described by Posidonius and Strabo, and particularly commended by Vitruvius, Pollio and Pliny. In 1791 they were again brought into notice by Giovanni Fabroni, in Tuscany, who, after many trials, succeeded in making bricks which would float upon water. Their strength was but little inferior to that of ordinary bricks; they are remarkable not only for extreme lightness, but also for their infusibility, and for being very poor conductors of heat; they may be held at one end while the other is red-hot. As an experiment, Fabroni constructed the powder-magazine of a wooden ship with these bricks; the vessel being set on fire, sank without explosion of the powder. In 1832, Count de Nantes and Fournet, a mining engineer, used them in constructing powder-magazines and other parts of ships, thus lessening danger from fire. From an earlier source (Encyclopædia Americana, II, 266), we are informed that these floating bricks, made of agaric mineral or fossil farina—infusorial earth—has been found, on account of its infusibility at the highest temperatures, to be extremely useful in constructing reverberatory furnaces, pyrometers, and magazines of combustible materials; while their lightness and non-conducting qualities render them particularly useful for the construction of powder-magazines on board of ships.

In agriculture, the use of the infusorial earth has been suggested as a manure for lands poor in silica, which substance enters importantly into the constitution of the stalks and outer coverings of cereals. Quite an animated controversy indeed has of late sprung up as to the merits of infusorial silica as a component of fertilizers, an idea which forms the essential feature of a patent lately issued to Messrs. N. & G. Popplein, Jr., of Baltimore. It would be foreign to the purpose of this sketch to enter into a discussion of the merits of this controversy, involving as it does the introduction of certain debatable questions in agricultural chemistry; but the ideas of the Messrs. Popplein have aroused on the one hand such warm championship, and on the other such opposition, that a concise statement of the points in dispute may not be amiss.

The manufacturers before named, proceeding from the well known fact that the relative quantity of silica in the ash of the cereals is greatly in excess of what is required for the normal combination with the bases (potash, soda, &c.) found therein, claim that in the ordinary course of things it is impossible for nature to furnish to cultivated lands for successive years the proper amount of silica in assimilable form for the plant, inasmuch as the liberation of this substance by the chemical decomposition of the mineral matters of the soil containing it, goes on so slowly as to render doubtful the production in many years of the amount required for a single crop. In proof of this assertion they refer to the great reduction in the yield of the wheat crop, since farmers began years ago to sell the straw of the crop that formerly was returned to the soil. For this, and other reasons less obvious, their attention was attracted to the importance of incorporating silica into commercial fertilizers—one difficulty remained to be overcome, namely, the discovery of a form of the silica—which should be assimilable by the plant. This they claim to have found in the infusorial earth—in which the silica is in an inconceivably minute state of division—the result of their consideration being the production of a so-called "silicated super-phosphate of lime," a super-phosphate with which the infusorial earth is intimately incorporated. The argument urging the importance of an abundant supply of silicic acid in available form, as an absolute necessity for the proper nutrition of cereals, is not disputed, and the manufacturers, to demonstrate the availability of the silica in the form in which they employ it, have actually succeeded in proving beyond question the highly interesting and novel fact that the very minute skeletons or shells of which the infusorial earth is mainly composed are carried up *as such* into the body of the plant itself. Upon this point, the following gleanings from an investigation conducted by Prof. P. B. Wilson will be read with interest.

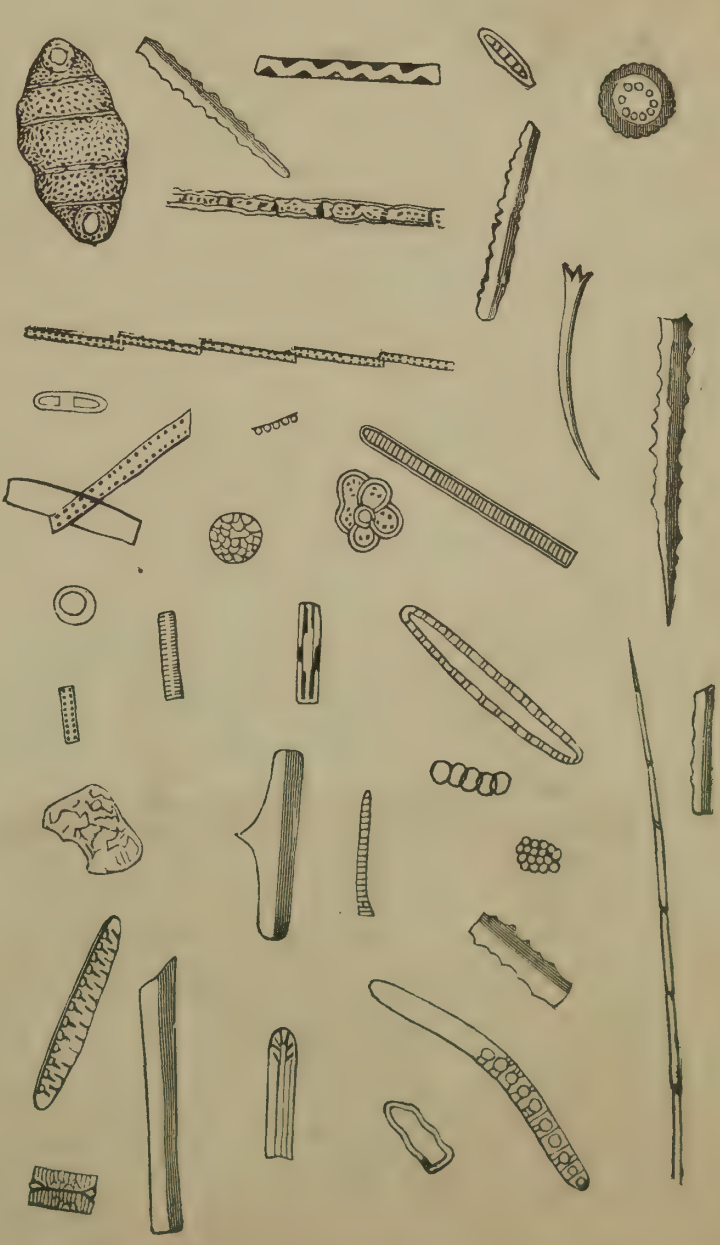
This chemist subjected to a microscopical examination, the straw from the wheat fields of Col. J. B. Kunkel, of Frederick county, Maryland, which had been fertilized by the silicated phosphate, his purpose being to make "a more complete investigation into the silicious structure of the stalk, in determining whether the infusoria passed directly as such into the sap-cells, to be carried forward by capillary force, and to finally assume their functions—the formation of the epidermal shield for giving strength to the straw, to withstand the destructive force of high winds and beating rains, as well as a protection against the attack of parasites."

"In making these investigations thorough precautions were observed, to cleanse the straw from all accidental impurities by washing and gentle friction, not sufficient, however, to destroy the epidermis. The organic matter was then removed by the prescribed methods, aided by my own experience."

"My labors," he continues, "have been amply rewarded by one of the most enchanting views that has ever fallen to my lot to behold through twenty years of varied scientific investigations. When the epidermal silicious coating was adjusted upon the field of the microscope, some thirty-six forms of the diatomaceæ, which I have carefully sketched, were observed (see engraving magnified 300 diameters) where perfect disintegration has been produced. When the structure to a great extent is retained, a marvellous interlacing of these forms presents itself, sometimes side by side, at other times overlapping."

Forms of Diatoms found in Col. Kunkel's Straw.

MAGNIFIED 300 DIAMETERS.



From this very interesting observation, Prof. Wilson advances a number of inferences, which, although the writer is not prepared to accept in full, are of sufficient interest to warrant their reproduction. He affirms that his investigation "overthrows all theories that have ever been advanced, that silica enters into plant structure in combination with the alkalies, the alkaline earths, or the earths proper. Chemical investigation led me to this conclusion some months since, now confirmed by that of the microscope."

"My mind was particularly impressed with the absence of the disc-like form, the *Actinocyclus ehrenbergii* and the *Actinoptychus undulatus* in their perfect state in the straw, while the other forms are common both to the infusorial earth and the wheat. My conclusions are that the varieties mentioned are too large to enter the root capillaries, for on the field of the microscope they have three to four times the magnitude of the others. This I will fully investigate during the coming summer, by making accurate measurements of rootlets and diatoms, when I will be able to obtain stalks of wheat as grown in the fields, preferring this mode of investigation to *pot culture*, to disarm controversy, and to divest the investigation of all semblance of laboratory experiment."

"I have examined various specimens of wheat straw taken at random from the market, but have failed to find a single diatom. This to a certain extent surprised me, when taking into consideration that they are found to a limited extent in Peruvian Guano. The inference to be drawn is, that the soil was not fertilized by any material into which it entered as a constituent. I mention this to guide others who may make subsequent investigations from falling into error, in case occasional diatomaceæ are observed, as being derived from other sources than the infusorial deposits."

"These microscopic investigations show the absence of other forms of silica, that is, in granular particles in the (Kunkel) straw, they being entirely replaced by diatoms. This leads to the conclusion that the diatom is the more acceptable for assimilation, and when sufficient infusorial remains are present, replaces any other divided form of silica. I have previously attempted to substitute silica for diatoms, as obtained from the decomposition of slags from iron furnaces, but have failed to derive any satisfactory results. This is due to its combination as a silicate; and when liberated by stronger acids, it agglutinates into masses too hard and large to be absorbed by the plant."

Prof. Wilson concludes his report in the following glowing terms: "I look upon this application of vegetable silica to fertilizing purposes as the most important adaptation of matter for the reproduction of vegetation that has ever been discovered. It is the first step in a new direction, rationally conceived and judiciously carried out. A new impetus will be given to the study of plant physiology, which will demonstrate that more than a heterogeneous mixture of elementary bodies and their compounds are required for the production of the crops beneficial to the requirements of man."

With regard to the foregoing statements and inferences of Prof. Wilson, while not attempting to undervalue their great interest and possible entire accuracy, the writer would remark that the demonstration of the presence of the infusorial forms in the structure of the wheat stalks, proves simply that these bodies are sufficiently minute to enter the root capillaries and pass into the sap-cells of the plant—nothing more. It may possibly be that once having entered the body of the plant, they are assimilated, and made to subserve to the function of giving strength to the stalk; or, as appears to the writer equally plausible, they may simply act as so many minute mechanical impurities drawn into the circulation of the plant, and, effecting a lodgement wherever they chance, clog up the passages, and thus actually obstruct rather than serve the process of nutrition. To follow the history of one of these forms in a living plant under the microscope, and observe its gradual dissolution, would afford the only method of positively proving the truth or falsity of either of the explanations that have been presented. While not presuming to decide so doubtful a question, it is very reasonable to believe that much of the silica of the so-called silicated super-phosphate is made "available" as plant-food in solution as an alkaline salt, in which condition its assimilation by the plant presents no difficulties to the understanding. Dr. Wolf, the excellent State Chemist of Delaware, has kindly furnished the writer the following record of an analysis of the "silicated super-phosphate," viz.:

Soluble Phosphoric Acid, ...	5.855 per cent.
Precipitated Phosphoric Acid, . . .	3.327 "
Insoluble Phosphoric Acid, ...	Trace.
Silica, ...	20.568 "
Sulphate of Potassa, ...	6.173 "

According to the Messrs. Popplein's published formula, the net ton of their "silicated super-phosphate" contains

Infusorial Earth, ...	800 lbs.
Dissolved Bone, ...	800 "
Potash Salts, ...	400 "

As an absorbent and carrier of liquids of various kinds, and especially as a carrier of nitro-glycerine, the infusorial earth has been found to be most excellently adapted. It takes up from three to five times its weight of water, oil, nitro-glycerine, &c. It would doubtless prove equally valuable as a carrier of carbolic acid and other disinfectants, as a disinfecting powder, and has possibly already found application for this purpose.

In order to bring nitro-glycerine within the range of articles of transport, Nobel, who first demonstrated its value in the arts, devised the production of the powder now so extensively employed under the name of dynamite, in which the explosive oil is simply carried by the inert, pulverulent silicious earth. The process of the preparation of dynamite may be described as follows:

The infusorial earth must first be freed from water, organic substances and mechanical impurities (sand, &c.). The first two are removed by calcining at a red-heat in an oven with several shelves, one above the other, on which the earth is placed and slowly pushed from the upper to the lower. The organic matter which is considered dangerous to the stability of the dynamite is thus burned out. It is then pressed with hard rollers and sifted, which separates it from the larger particles and grit. It is now ready for use.

Fifty pounds of infusorial earth are put into flat wooden tanks and covered with one hundred and fifty pounds of nitro-glycerine, when the workmen mix them with the naked hand. Gloves of india rubber were at first provided, but the workmen preferred to knead the mixture with the free hands. In half an hour the incorporation of the oil with the earth is complete, and the dynamite is ready for filling in the cartridge moulds. The cartridges are simple cylinders, protected by parchment paper. If ordinary paper is used the oil soaks into it, and there is great danger of premature explosion. Dynamite is a brownish gray, sometimes reddish, inodorous, pasty, greasy mass, having the specific gravity of 1.6. When ignited by an ordinary flame it burns up quickly without detonation, and must therefore be fired with a patent exploder containing fulminate of silver inclosed in a copper capsule. It requires a heavy blow of a hammer on an anvil to explode it, and even then only the portions struck are fired. In this respect it presents great advantages over nitro-glycerine, which is easily exploded by percussion. On the other hand, the wood of the boxes in which dynamite is packed, becomes by slow degrees impregnated with nitro-glycerine, and forms a most dangerously explosive material, which may give rise to serious accidents in warehouses where it is stored. As long as the nitro glycerine is confined in the infusorial silica there appears to be very little danger, but the escape of a few drops of the oil may be the source of great mischief. The force exerted by the dynamite is much greater than that of gunpowder, and under the name of giant powder it has been largely employed in the mines of California. Other explosives, such as dualine and lithofracteur, may be said to be varieties of dynamite, having nitro-glycerine for their base and using saw-dust or some other substance as an absorbent. All of them are powerful explosives, and must be handled with care.

For the preparation of cements and of artificial stone a number of processes have been devised, in which infusorial earth plays a prominent part, viz.: Equal parts of infusorial silica and litharge, and one-half part of slaked lime, stirred to a paste in linseed oil, is affirmed to become as hard as sandstone on setting, and is recommended as an excellent compound for cementing stone, metal and wood. The following recipe, again, is pronounced to be serviceable for the production of an artificial stone for art objects. For this purpose the infusorial earth is intimately mixed with well pulverized, freshly burned lime, in the proportion of from three to six parts of the former to one of the latter. The mixture is then pressed into moulds under an addition of a very slight quantity of water. The resulting product, a silicate of lime, is formed with the evolution of considerable heat. The objects produced ultimately attain great hardness; they are perfectly water-proof, and may readily be colored with any color used in stereochromy.

In combination with sulphur, infusorial earth forms a plastic mass, called zeiodelite; but no uses have yet been made of it.

By far the most important application of infusorial earth in this direction, however, has been successfully accomplished by Mr. Frederick Ransome, of England, in the production on the large scale of an artificial stone for general purposes, to which he has given the name of apoenite. The so-called "Ransome stone," invented by this gentleman, is made by thoroughly incorporating sand and silicate of soda in a mixing mill, moulding into the form required of the block, and then saturating the same with a solution of chloride of calcium, either by exhausting the air with air-pumps, or by forcing the solution through the moulded mass by gravitation or otherwise. The result is the formation of an insoluble silicate of lime, which firmly cements the particles of which the mass is composed, and of chloride of sodium or common salt, which is subsequently removed by the free application of water. The process of washing to remove all traces of the salt from the Ransome stone, which is necessary to prevent its efflorescence and secure its proper cementation, was found to be in many cases so tedious, expensive, and objectionable, that the inventor, after many experiments, devised the following process, in which the use of chloride of calcium is avoided. Mr. Ransome mixes suitable quantities of lime (or substances containing lime) and soluble silica (i. e. infusorial earth) with sand, and a solution of silicate of soda or potassa, which, when intimately incorporated, are moulded as before, and allowed to harden gradually, as the silicate of lime, produced by the action of the lime on the silicate of soda, is formed. As rapidly as the soda (or potash) of the water-glass solution is set free, it dissolves some of the infusorial silica, and again gives it up to the lime to form more cement, acting thus as the carrier of silica to the lime, until eventually all the lime is combined. In the course of the successive changes that take place, a portion of the free alkali appears to be bound, at each step, with the lime as a compound silicate, and as the result of these several changes, the whole of the alkali is gradually fixed, thus leaving nothing to be washed out. The mass gradually becomes thoroughly indurated, and in a very short time is converted into a very compact stone—apoenite—capable of withstanding enormous pressure, and increasing in strength and hardness with age.

In combination with magnesite (carbonate of magnesia), infusorial earth forms what is described as an excellent cement, which is manufactured in Germany, and sold under the name of "albolite."

In pottery, the infusorial earth has received several important applications. When fused, for example, with borate of lime, as such is obtainable in the trade under the name of boronatrocalcite or tincalzite, an excellent glazing is produced [*Manufacturer and Builder*], which is not only useful for furnaces and pottery of all kinds, but also for enameling iron and slate, being free from lead and not apt to crack off. By fusing a mixture of infusorial earth (freed from sand) with borate of magnesia (stassfurtite), a kind of "hot-cast porcelain" is produced, having great durability and beauty. For this purpose the infusorial earth requires to be perfectly dry and free from lumps. It is introduced into the crucible in small portions and under constant stirring, until the fused stassfurtite ceases to take up more. The mass may be cast like glass, and if very liquid it may even be blown, and is thus fitted for an extensive application [*ibid*].

Boettger publishes the observation that when an alcoholic solution of any of the coal-tar colors is mixed with a sufficient quantity of infusorial earth, water added, and the mixture filtered, the liquid will run off clear, while the earth retains all the pigment. Hitherto the compounds of alumina have been used for the production of the so-called lakes, and it is quite probable that the above-noted behavior of this material may find important applications in the arts.

The use of infusorial earth has been suggested in glass making as a substitute for sand; but it appears not to be well suited for this purpose, the reason assigned being that it swells too much in the crucible. In the manufacture of soluble glass (water-glass), for which it has likewise been tried, the impurities it contains—clay, phosphate of lime, &c.—have been found to render it somewhat unsuitable.

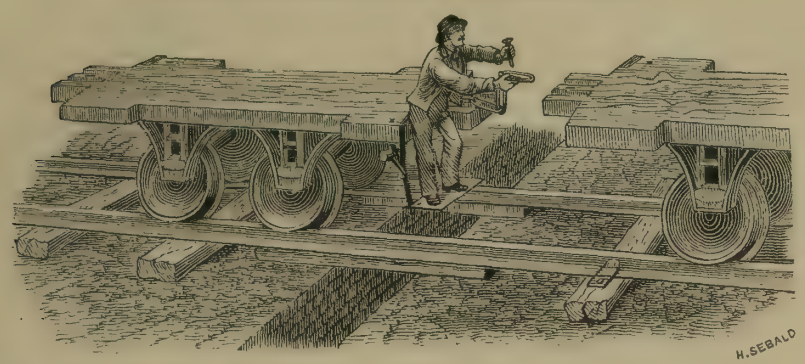
To conclude a sketch which has unwittingly taken on considerable proportions, the following enumeration will suffice to show that the subject is by no means exhausted:

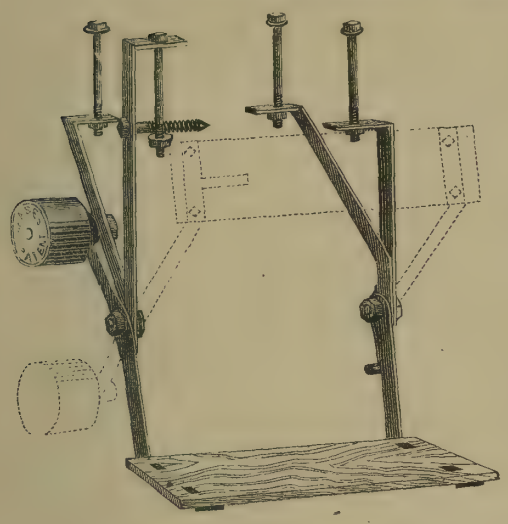
A compound called diatite, devised by Merrick, consists of gum-lac and infusorial earth. The siliceous earth has been added to sealing-wax to prevent its running; it is sometimes added to paper to give it body; and to soap for the same purpose, and to add

to its detergent qualities (?); and it is said to form an excellent addition to rubber, for certain uses of the latter; its addition to modeling clay is said to prevent it from cracking in moulding; and lastly, though doubtless many real or suggested applications of this curious substance have been overlooked, it is said to be of use in the manufacture of smalt and ultra-marine.

*

HAASE'S BRAKEMEN'S SAFETY-SWINGING-STEP.





The cuts show a device for attachment to cars having the ordinary link and pin coupling, and designed to afford a safe and sure foothold for the brakeman in the heretofore dangerous operation of coupling. The brakeman will turn down the step and stand thereon, instead of running on the track ahead of the approaching train. The counterweight being near the "dead-centre" when the step is down, causes the latter to turn up gently and out of the way (keeping clear of dirt, ice, &c.) after the man steps off.

LEATHER—CHANGES OF STRUCTURE.

Leather is capable not only of receiving a variety of forms and subserving a variety of uses, but may be so changed in character as to resemble greatly differing substances. When fresh from the tanning process, leather is porous, pliable, soft, and somewhat spongy, pervious to air and water. Sheepskin for the bookbinder, skins of the kid, goat, rat, or other peltry employed in the making of shoes, gloves, &c., all admit water.

The ordinary dressing of skins, as practised by the hunter and Indian, and sometimes by our country boy, is simply a method of arresting decay in the skins, not analogous to the process of converting skins or hides into leather. The process of decomposition is arrested, but the nature of the material is not essentially changed: the skins are rendered soft and pliable and fitted for civilized uses. Every farmer's boy who ever prepared a woodchuck's skin for a purse, understands how, with lye, alum, and repeated workings, he can produce a satisfactory result. But these skins are not leather; a tanned hide is a different article. The tanning materials are not necessary in the soft curing of skins, but in manufacturing leather *tannin* is absolutely necessary. This is obtained from a decoction of certain vegetable substances, astringent to the taste, like alum, sometimes used in the preparation of skins; but alum alone will never change a skin into leather, and even for the curing of skins it is not necessary: the Indian women never use it.

The removal of the hair of a hide by lime, and the currying to clean from fleshy particles, are only preparatory to the conversion of the hide into leather.

The strong tanning liquor is made, by heat and by frequent working or handling of the hide, to permeate its entire substance, the powerful astringent contracting the fibres and closing the pores; yet the manufacture is not completed with the withdrawal of the hide from the tan-vat. It is still too porous for many of the uses to which it is to be applied. Its substance must be compressed: the shoemaker with hammer and lapstone is a familiar illustration of the process. To some extent leather is like lead—malleable—and can be made much more compact by pressure and percussion. The roller machine has taken the place of the hammer and lapstone; but its office is the same. The rollers between which the leather passes are brought toward each other by a powerful leverage, and as the points of approximate contact are infinitessimally small, the pressure on the leather is very great. In large belt-making concerns, enormous machines of a similar character are used to treat an entire ox-hide at once. There is employed, also, a reciprocating roller, turning in boxes at the end of a vibrating vertical bar, traversing over a curved table, corresponding to the arc described by the bar. The leather is introduced between the roller and table, and the latter is gradually raised toward the roller. The result is a powerful rolling pressure on the leather, so effective that it is easy to see the hide gradually diminished in thickness as the work goes on. Leather thus treated almost changes its nature—its structure is changed—from being a cellular mass, it becomes fibrous, rigid, impacted. Its elasticity and toughness remain, but it no longer allows water to pass between its particles except under extreme pressure. The "English bend" leather, so valuable for single soles to boots and shoes, is simply a finely tanned leather, compacted by mechanical means, and does not derive its superiority from any peculiarity in the method of tanning. The linings of the valves of the great Cornish engines, used to keep deep mines free of water, being of leather, are eagerly sought after by the workmen when new leathers are put in. The old leathers are considered very superior for soles to boots and shoes, on account of the immense pressure to which they have been subjected for weeks and months in supporting the weight of a high column of water. Under such circumstances leather becomes almost as hard an impervious as iron. L.

HARBOR IMPROVEMENT AT GALVESTON, TEXAS.

The harbor of Galveston, Texas (like many others along our coast), was inaccessible to vessels of great draft, by reason of obstructions of sand-bars. Such a chain of bars encircles our entire Atlantic coast. The depositions are caused by the meeting of contrary currents holding matter in mechanical suspension. This matter, for one hundred miles from Galveston, is a fine, round sand. To gain access to these harbors, a channel must be formed, either by dredging or by "scouring," this last being effected by jetties, causing concentration and deflection of the currents upon the line of required increase in depth. The success of this "jetty" system is a matter of world-wide knowledge; and their application at the delta of the Mississippi, under the skilful direction of Captain Eads, is rapidly opening our rich interior basin to the maritime commerce of the world.

The authorities of Galveston had made, at an expense of $180,000, a breakwater of piles driven from ten to fifteen feet into the sand, and strongly braced and capped. The violence of the waves prevented the requisite extension of this breakwater. Captain C. W. Howell, U. S. E., having suggested jetties formed of gabions made of cane, covered with cement and filled with sand, the government made an appropriation of $60,000 for an experimental jetty-system at Galveston. Work was commenced in September, 1874. In November, the work of gabion-placing began. Upon the completion of a number, they were arranged on a platform convenient for launching, and, when the cement had properly hardened, were lowered into the water and floated to their place in the jetty and sunk by being filled with water. Rough weather interrupted this work, and a severe three days' storm severely tested that already completed. It was found that the gabions were substantially unmoved; had not settled or been undermined; the sand had banked against them on both sides; and they were quite effectual in arresting the currents produced by the tides (quiet water existing in the rear of the jetty they formed), and they arrested the travelling sands.

To make a gabion 6 feet in diameter, 6 feet high, required:

24 stakes, 7 feet long, @ .09,	$2.16
675 withes, @ .87½ per 1000 feet,	5.81
140 feet lumber (tops and bottoms), @ $20,	2.80
1¾ barrels Rosendale cement, @ $2.65,	4.64
¾ barrel lime, @ $2.40,	1.80
16 cubic feet sand, @ .11¼,	1.80
4 cubic feet shells, @ .06½,	.26
5 cubic feet bricks, @ .15,	.75
1 iron bolt, 6 feet 4 inches long,	.84
4 lbs. nails, @ .06,	.24
Wire fastenings and contingencies,	1.00
Materials,	$22.10
Labor (at the rate of 100 gabions per month),	30.70
	$52.80
Fascines and mat protection,	4.60
	$57.40
Piers per running foot, gabions in two rows,	19.33

Running 200 gabions monthly, the cost is reduced from $57.40 to $48.12 per gabion.

The carpenters prepare the wooden tops and bottoms of 2″ plank; at the weaving grounds the stakes (pine poles, with the bark on) are set up and the matting completed; they are then well cemented on the inside, the top put on, and the stakes nailed thereto. Two ¾ iron bolts pass through the top and bottom, and bind the whole together. The outside is coated twice with cement, and then the whole allowed to stand two weeks before use. A single row is then fastened at each side of the vessel, thus:

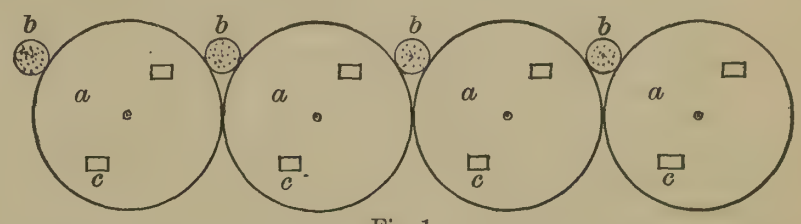


Fig. 1.

[*a*, gabions; *b*, fascine; *c*, openings through which the gabions are filled with sand],

and they are then taken to their positions. To protect the gabions from the rebounding current, mats are made by binding canes (with their small branches on) to wooden frames. These are held in place by concrete weights. The foundation being generally uneven, it is not possible to bring the gabions close together at the bottom, about two or three inches being usually left between them, to prevent undermining, which would allow the gabions to sink about half their depth. To close this passage, a short fascine is made of the branches trimmed off the canes, and this is crowded into the interval and held by a concrete weight.

To insure the gabions sinking in position, guide-piles are placed every twelve feet and "pumped down." The gabions are then launched by elevating the rear end of the tracks on which they stand; the first row is floated against the guide-piles, filled with water, and sunk; the second row is placed beside them, and the top secured; they are then filled with sand by a pump, and the weighted mats put down to prevent their being undermined. If they are in such deep water that the flexible discharge-pipe of the sand-pump will not reach them, a wooden trough is placed in the hole in the cover, and the discharge-pipe connected to the top of this. The cement protects against ship-worms. There is nothing perishable in their filling. As each sand-filled gabion weighs 17,000 lbs. and is entirely submerged, it would require a current to press 400 lbs. to the square foot to overthrow it. The additional security afforded by the second row of gabions did not warrant the expense. The following change from a double to a single row was recommended (Fig. 2.):

Gabions to be the same size; a fascine to close the intervals between them on the channel side; a guide-pile to each alternate gabion on the sea side, and both sides protected from undermining by a brush-mat held in place by concrete blocks.

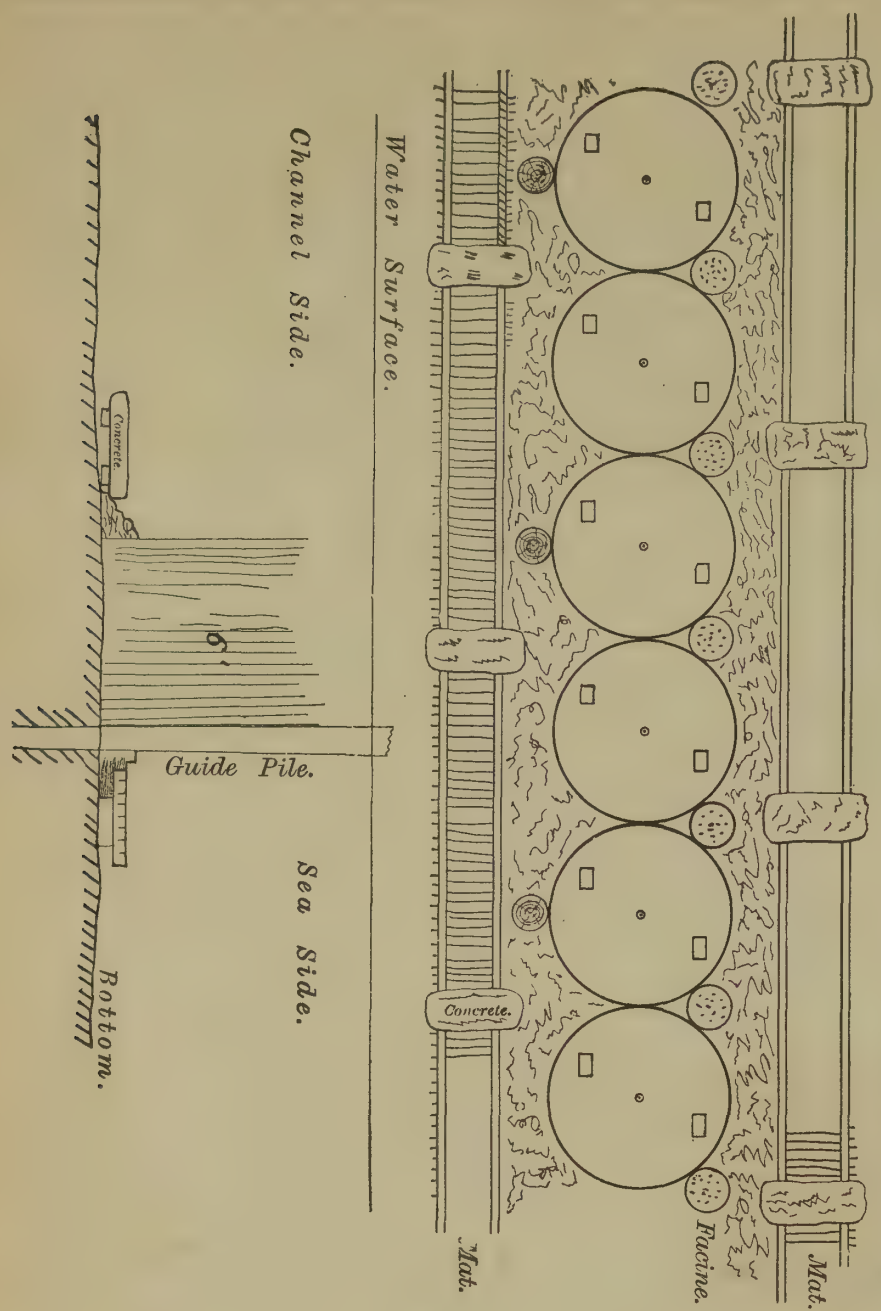


Fig. 2.

But one thing was fatal to the permanency of the gabions—the scouring out of the channel to such an extent as to cause them to slide in it. This defect it was possible to remedy at intervals by extending at intervals cross or side jetties, as shown in Fig. 3.

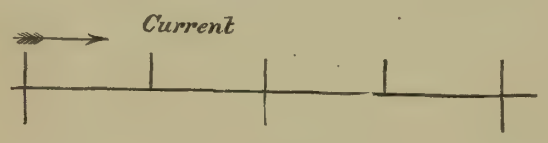


Fig. 3.

The cut shows the amount and manner of accretion at the beginning of 1875. It will thus be observed that the rapidity of accumulation was beyond even the most sanguine expectations. (See Fig. 4.)

In January, 1875, the workmen were driven off by storms, leaving the gabions in the position shown by Fig. 5.

After a week's subjection to the fiercest kind of storms and the strongest kind of currents, resulting observation showed that the extremities had settled from three to four feet; those on the angle of the short jetty and main jetty had settled two feet; those unprotected by mats had settled most on the line *d*—the sand had scoured out to twelve feet from nine feet; it had filled in at *c* and "*E*," and in the angle *a* and *b*.

It is to be observed that the tide did not flow in a direction perpendicular to the jetty, but in a position nearly parallel. None of the gabions were overturned or displaced, though they were certainly in a most exposed position to encounter the storms which had come from every point of the compass since they had been placed. There appears to have been one point overlooked when parties discussed the probabilities of the gabions being overturned, and that is, that, admitting they are overturned, unless there is a hole excavated for them to fall into, they will still form a breakwater of nearly the same dimensions as before.

The outer extremities would be undermined and probably settle to the limit of the scour, and eventually take the position shown by Fig. 6.

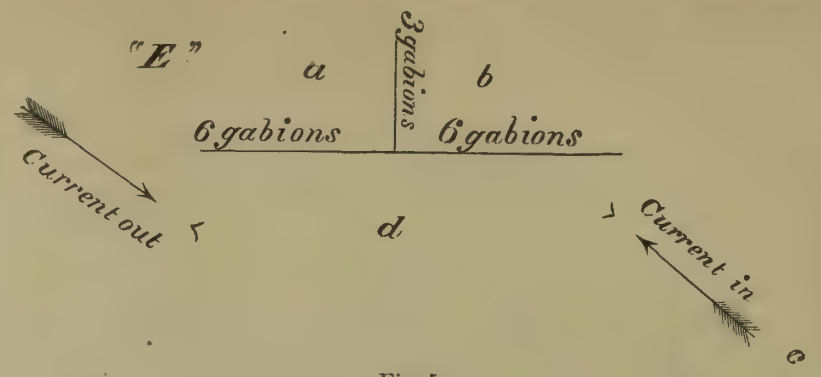


Fig. 5.

Experiments with Trinidad bitumen and sand, developed no economy over cement. Sea-cane was substituted for willows, in wattling, with marked economy.

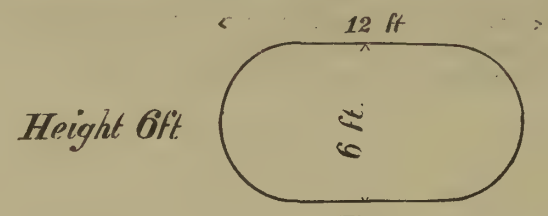


Fig. 7.

The length of the gabions was increased from six to twelve feet, with economy and advantage.

TYPE, PRESSES, AND THE "WEE SMA' HOURS."

A recent midnight visit to the stereotyping department of the *New York Herald*, was well repaid. Mr. E. L. Henderson, the superintendent, very kindly explained the entire process of making paper matrices, and stereotype casts from these. The writer timed the operations, with the following result:

At 12.24 the form of the fifth page of the *Herald*, bearing date of March 21st, came up in an elevator from the composition room. It was slid on to a long iron table, oiled with a roller, and a sheet of thick tissue-faced paper (dampened) and then a blanket placed thereon. The whole was run under a heavy roller and back again, forcing the paper into the finest recesses of the type, by 12.26; by 12.27 the depressions were filled with plaster; by 12.28 the paper and plaster were coated with thick size, and another thick sheet of paper applied as a backing. A blanket was then laid on all, and the whole "hot-pressed" in a steam press until 12.34; by 12.35 the matrix was removed, trimmed square and "dusted;" by 12.36 it was snugly curved in a semi-cylindrical iron casting-box, and a semi-cylindrical iron core with peripheral corrugations clamped so as to leave a semi-annular space of about ⅜ inch; by 12.36½ the melted metal was dashed in from the adjacent kettle; by 12.37 the mould partly cooled by a dash of water, and the curved cast removed; by 12.37½ this cast was placed on a semi-cylindrical horse, and the end trimmed and beveled by a vibrating circular saw; by 12.38½ the relief was improved by rapid chiselling in open spaces; and by 12.39 the inside was dressed neatly to gauge by a rotating planing-bit. The dumb-waiter then received the completed and yet hot cast, and sent it down six or seven stories into the basement press room. Time of operation 15 minutes; of which 11 were occupied in making the paper mould. From this same mould *ten* casts are taken for the turtles of the single and double Bullock presses. These last receive the paper in a continuous web, print it on both sides, divide the twin sheets and cut them off, and flirt them out in four piles at the rate of 15,000 sheets per hour for each double press. The pressman, Mr. Hale, keen-eyed and alert, motions or shouts to his assistants to stop or adjust the presses or paper on the discovery of a fault or break. The hum of the whirring wheels, the soft crackling or kissing of the rollers, the rustling of the flying paper, the shouting and rushing to and fro, the glittering lights and dancing shadows, are exciting in the highest degree. †

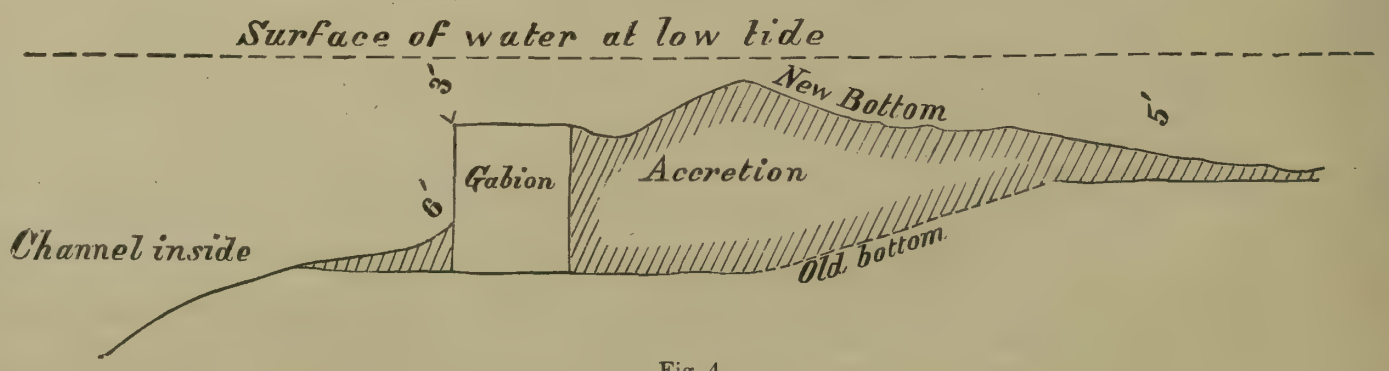


Fig. 4.

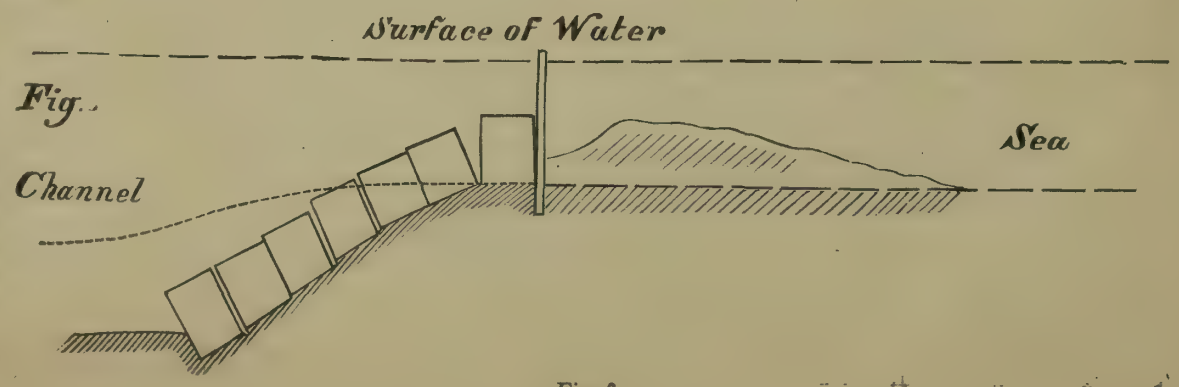


Fig. 6.

TWO LECTURES ON THE GEOLOGY OF THE AMERICAN PIEDMONT IN PENNSYLVANIA (YORK AND ADAMS COUNTIES).

[Delivered before the Franklin Institute, by PERSIFER FRAZER, JR.]

LECTURE I.—*Origin of Geological Surveys.*

The epoch which ushered in rational scientific speculation to replace the crude imaginings of the old philosophers, in regard to the true causes for the appearance of the earth's surface, was due to the labors of Frascatera and Pelissy, who distinguished groups of strata, and by Lister, who recognized the difference between the fossils and living forms. Arduino had studied the rocks with reference to the periods of their formation. Desmarest constructed a map of the Auvergne district of France, and on which the geology was laid down with the assistance of topographical surveys. From him may be said to date the modern geological survey (1760). Lister had proposed such a map in a communication to the Royal Society (1683). Hutton and Werner led men's minds to the importance of the subject. William Smith constructed the first table of the order of British strata in 1801. Close upon this followed geological surveys by Maculloch, of Scotland, Von Buch, of Germany, and the Mining Engineers of France. North Carolina instituted the first geological survey in this country in 1823, and South Carolina followed her example. In 1836, geological surveys were started in New York and Pennsylvania, and since that day most of the States of the Union have had geological surveys begun or completed.

The rocks of the globe are divided for simplicity into three great classes—the Palæozoic, the Mesozoic, and the Cainozoic. Each of these represents the accumulations of thousands of feet of deposits made when the present land was under the sea. But, besides, there are the recent formations of no inconsiderable thickness, and the Eozoic at the beginning of all, of unknown, but certainly of vast thickness. The difficulties encountered in estimating the true thickness of rock formations when the region is full of plications, was well illustrated by the section of the quartzite and hydro-mica slates along the Susquehanna, near Wrightsville. The strata of our State exhibit a general N. E. and S. W. strike, which is more northerly and southerly at the upper and lower borders, and more easterly and westerly in the middle portions. The southeastern part of the State, up to the barrier of the first (south) mountain range, has been aptly called the Piedmont of America, and the older members of the palæozoic series which occur here will form the principal staple of this lecture. Near the State of Delaware the rocks are more gneissic and crystallized; in York and Adams counties more slaty and crystalline. The slates of this latter region abounding in iron ore banks, has, until recently, been falsely called the Talc slate district. The material which has been taken for talc, from its unctuous feel, is really one of the hydro-micas allied to Damourite, &c.

These slates with milk quartz veins, and including vast chlorite beds, form the flanks of the south mountain. The body of the south mountain itself is made up of quartzite; a conglomerate of quartz pebbles in an unctuous schist, and a peculiar and at times very beautiful porphyry, consisting of crystals of feldspar imbedded in a silicious felsitic mass. This rock (called ortho-felsite porphyry) makes a beautiful building-stone when polished, as a specimen exhibited proves. The limonite deposits are probably partly infiltrations, partly alterations in situ of the pyrites which infests these slates. A thirty foot section, enlarged from Section VII, of Rogers' final report, exhibited the relation of these among the oldest rocks of the State to overlying Devonian, Red Sandstone, and Coal Measures.

A selection of specimens to illustrate the characteristic varieties of this locality was then exhibited, with products of economic value derived from them.

In conclusion, the relation of the geology to the scenery was illustrated by a large number of photographic views which were projected upon the screen.

LECTURE II.—*The Middle Age Formation.*

The subjects of this lecture are 1st, the "middle age" formation, represented in its earlier growth by the New Red Sandstone, and called so provisionally, without attempt to define its parallel in either Trias, Lias or Jura, of Europe. Many things are remarkable about this formation. 1st, its color. All over the known world it is distinguished by the bright red color of some of its layers; its lack of coherence; its alternation of loose half compacted sandstones and shales; the frequent presence within it of deposits of salt; and last and most remarkable of all, it is cut up everywhere by dykes of once molten rock, which appear to exercise a discrimination in favor of the rocks of this age. This statement must strike the least profound thinker as remarkable, and a little reflection will make it more so. The New Red occupies troughs in the older rocks and of course rests upon them, though not with parallelism of bedding. According to any reasonable theory of the origin of outflows of molten matter, they must come from the earth's interior. If this be so, no matter what the age may be, they must penetrate all the older rocks before breaking through the newer. The thicker the covering of the older crust by newer depositions the greater would seem to be the resistance to such outflows, and thus when it is seen that these Silurian and Devonian troughs are covered with thousands of feet of Mesozoic Red Sandstone it is difficult at present to account for the fact that while the latter were forming, and after they had been formed, such outflows should take place, and that they should be almost exclusively confined to the area covered by it. Another singular fact observable wherever this formation is visible—in New York, New Jersey, Pennsylvania or Maryland—is that the rocks are tilted upon the S. E., and the layers descend to the N. W., at a gentle angle of about 30°. In Connecticut, Prince Edwards Island, &c., they dip generally S. E., and in North Carolina separate belts have opposite dips—that in the eastern portion of the State dipping S. E., and that in the western part N. W. To estimate the shelf-room necessary for a given number of volumes one must straighten them up, and the thickness of a series of inclined beds is obtained by straightening them up by calculation. It is easy to see that where a series of beds in some cases twenty miles broad incline one above the other even at so small an angle as 30°, the thickness of these beds if straightened up would amount to ten miles or 52,800 feet. Now, as the entire thickness of rocks of all formations yet measured amounts to little over 100,000 feet, it would imply that this hastily formed estuary deposit was over half as thick as the whole series, which is improbable. Leaving the solution of these difficult problems to the future, let us turn to a new and interesting subject, and one capable of beautiful illustration to an audience.

When a boy receives a toy hatchet he tries it on all solid articles in nature within reach. The scientific boy used his microscope in the same way. In this way d'Aubenton studied the arborescent bodies in crystals. William Nicol (inventor of the prism) invented the process of slicing crystals and rocks in 1831. Humphrey Davy and David Brewster pursued this branch, and in 1858, Sorby published his microscopical study of crystals. Since then Zirkel, Rosenbusch and Tschermak, added much to the literature. The object of this branch of study is to extend our vision downwards so many steps towards the constituent molecules, and to observe how matter behaves to chemical and physical agents. The results are the discovery of little crystals $\frac{1}{10000}$ of an inch in length, out of which the larger are built by polar attraction. Bodies once called heretofore amorphous and glass-like (pitch stone, &c.) are resolved into a garden of minute crystal flowers or a bone-yard of crystal fragments. Gases and liquids which have been imprisoned under immense pressure millions of years ago are detected filling the pores of otherwise solid masses. Perhaps the most important use to which micro-mineralogy has been put is the determination of the character of the congealed trap rock. Traps have been divided into different systems, by different experts; one of the simplest of which (that of V. Cotta) has for its vertical divisions, volcanic or those igneous masses which have cooled comparatively near the surface, rapidly, and under small pressure, and Plutonic, or those under opposite condition; and for horizontal division, Acidic (or those containing over 66 per cent. of silica), and Basic (or those containing less than this).

As types of these several types we have

	VOLCANIC.	
ACIDIC.	Trachyte, &c.	Basalt, Dolerite, &c.
	Granite, &c.	Greenstone, Syenite, &c.
	PLUTONIC.	BASIC.

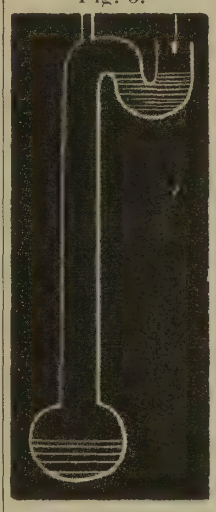
We will not have time to explain what minerals constitute each of these rocks, nor how each affects polarized light. But here are examples which each can see for himself. (A large number of thin slices prepared by the lecturer were here projected on the screen, and the means of establishing the identity of their several constituents was explained; after which, positives on glass, photographed through the microscope to 4″ x 3″, were projected as 10 feet circles, thus making a total superficial enlargement of over 2,250,000 times. A number of these pictures were photographed at successive positions of the analyses in polarized light, under the direction of Prof. Frazer, and will appear in his reports on this subject in the publication of the second geological survey of Pennsylvania).

THE REMOVAL OF NIGHT-SOIL.

III.

Tapping the soil-pipe below the trap, or tapping the cess-pool or sewer, with a pipe leading to the air above the house-tops, or into chimneys, affords no influx of fresh air. It equalizes pressure and prevents forcing, but does not prevent absorption by, nor fermentation in, the trap or pan.

Fig. 3.



Dr. Fergus found that gases were passed through the trap and into the house in from fifteen minutes to four hours. (See *Sanitary Record*, December 18, 1875.)

When the trap and pan are unsealed (from whatever cause), gas will seek an exit through the closet in preference to the vent-pipe, because it *prefers the shortest road*. We must then ventilate on the house side of the trap, and afford the gases the shortest possible avenue of escape.

Fig. 4.

Fig. 4 shows a pipe with equal branches. Gas entering from below will escape through these in equal quantities. If one branch be lengthened, as in Fig. 5, a slight increase of temperature in it will induce a syphon action—air flowing in at the short branch and out of the long one. Gases of dissimilar nature and temperature do not mingle rapidly; hence this air current (shown by straight arrows) will flow along the upper surface of the tube, and will not entirely prevent the foul gases (shown by waving lines) from escaping at the short branch. This is illustrated in Fig. 6, which shows an old mode of attempted ventilation. If now the short branch have a tapering pipe inserted therein (Fig. 7), the air current is concentrated and delivered in the centre of the gas current, and no gas can escape through the little end of the funnel. This principle has been admirably applied to the ventilation of water-closets. In Fig. 8, the neck of the hopper is the conical plug, and a flow of gas through it, however slight, obstructs the escape of sewer gas by that way. There is no pan or valve.

Fig. 5.

Fig. 6.

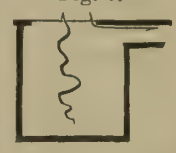


Fig. 7.

Fig. 8.

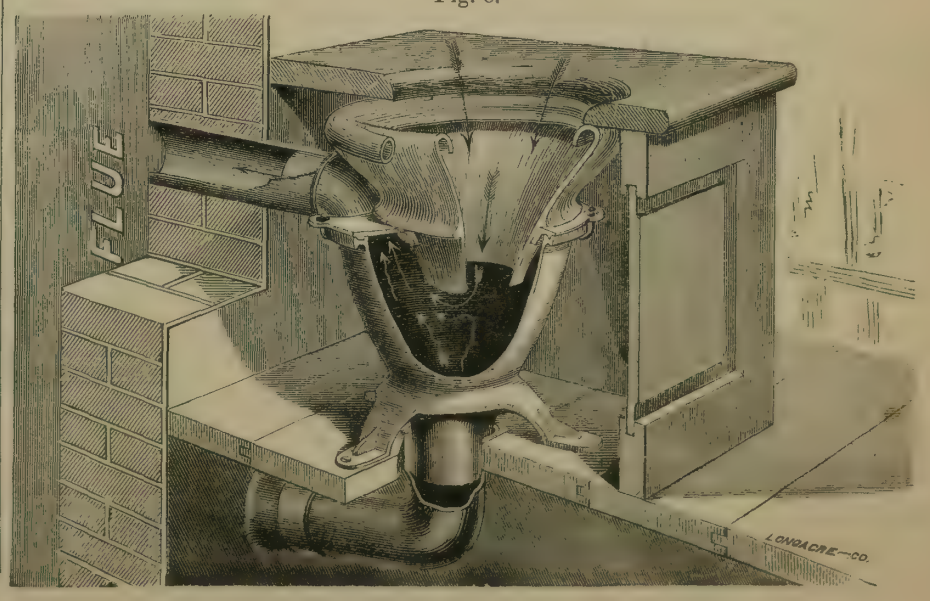


Fig. 9.

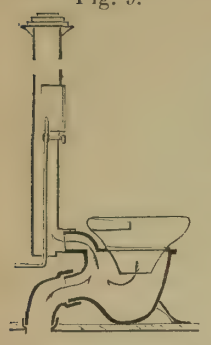


Fig. 9 shows the container with a "catch-bowl" at the bottom. The ventilating pipe is shown, as carried up through the roof without communicating with any flue. It is provided with a proper cap, and a gas pipe is inserted, so that a little flame can be produced to force a draft when natural causes fail. A flame consuming one-fourth foot per hour will suffice. This gas burner may also be constructed to heat the rising column of air and gas, and render it innoxious. When a gas burner is so inserted, a small glazed door is set in front of it, through which it may be observed, and its light utilized.

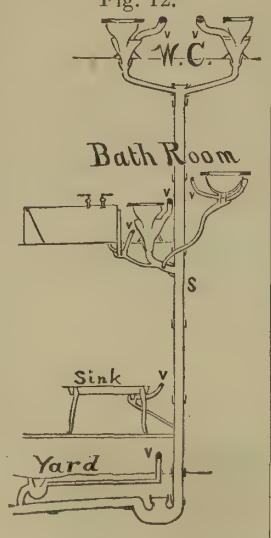
Fig. 10.

Fig. 10 represents the proper method of connecting on different levels with an up-take flue or chimney, especially when the same is a smoke flue. The upturned inner end of the ventilator will facilitate the draft and prevent the backing in of smoke.

When the trap is placed immediately below the container, as shown in Fig. 11, the soil-pipe below is filled with sewer gas, and often under pressure in excess of the atmospheric pressure. It therefore seeks an escape through any joint where there is the slightest defect in caulking, or through any orifice, however minute, in the metal of the pipes, as shown by the small arrows. It is useless to say that no good workman will permit any such opportunities, for it is notorious that good workmen are not always employed, and that such defects are of constant occurrence. Besides, it is impossible to caulk behind a pipe set up against a wall or in a niche. With the odorless closet the plan of trapping is shown in Fig. 12, which represents the piping with closets, &c., on three stories of a dwelling. A single *running trap* is put in so that the hand-hole will be accessible just before passing under the wall of the building; and this will be mainly useful to prevent currents of air which blow into the open mouths of sewers, from passing through the laterals and into the house. Any sewer gas which is generated in, or finds its way to the soil-pipe above the trap, will, when it rises to the closet or other opening, pass into the ventilating flue at V, and thence to the air above the house-top. One trap therefore suffices for the whole system of drainage for one establishment. The form of a running trap renders it less likely to clog than an S trap.

Fig. 11.

Fig. 12.



The invention of the "flexible mandrel" renders it extremely easy to obtain cheap seamless lead or wrought iron S traps, which would greatly diminish the risk of leakage.

(*To be Continued.*)

UTILIZATION OF ANTHRACITE COAL-DUST.

A COMBINATION OF APPARATUS BY WHICH ORDINARY ANTHRACITE COAL-WASTE, FROM THE DIRT-BANKS AT THE MINES, CAN BE SUCCESSFULLY AND PROFITABLY BURNED IN THE FURNACES OF STATIONARY AND LOCOMOTIVE BOILERS.

BY JOHN E. WOOTTEN, READING, PA.

[*A paper read before the American Philosophical Society, March* 3, 1876.]

Prominent and peculiar features in the landscape of the Coal Mining Regions are the enormous heaps of black and apparently useless material collected near the outlet of each mine. The nature of this material can be best understood by a brief consideration of the source from which it comes.

The coal measures are made up of veins of coal of varying thicknesses and constitution. The coal of which they are composed, especially in the thicker veins, has mixed with it layers of slate, sometimes in mass, at other times finely laminated and disseminated throughout the seam.

As the coal is found in beds interstratified with rocky formation, it is subject to similar accidents as are the rocks themselves when disturbed by convulsions of nature; therefore when portions of a vein are crushed and rendered unfit for use as marketable fuel, it must, notwithstanding its unfitness, be removed from the mine to permit access to the more valuable coal.

Seams of considerable thickness are usually divided into separate beds of varying thickness, by deposits of slate, which impurity must be removed in the preparation of the coal for the market; and the same seam may furnish several qualities of coal.

The great heaps of material to which we have referred, are thus the results of the various operations of mining and preparation of the coal for market. They contain, therefore, in addition to the earthy matter, slate and rock already mentioned, a large portion of the purest coal taken from the colliery; not only that which is crumbled into small fragments during the operation of mining, but also that which having passed through the breaking rollers is crushed into particles of too small size to be merchantable, and is for that reason consigned to the dirt-heap. The last named contribution to the heap constitutes from twelve to fifteen per cent. of all the good coal that is mined, and is the result of the wasteful method which is employed to reduce the large lumps to the uniform sizes required by the demands of the trade.

Some of these heaps are the accumulations of half a century, and have been exposed during their formation to the action of the weather and such atmospheric influences as have lessened their value for heating purposes by loss of carbon and saturation with moisture.

We have, therefore, in dealing with these masses as fuel, to overcome the difficulties consequent upon their containing a very large amount of incombustible matter, all of the elements for the ready production of clinker and incapability for producing an active or vigorous fire in the ordinary furnace.

To consume this material with useful effect, it is necessary either to subject it to a process that shall form it into masses of moderate dimensions, so that when thrown into a furnace, interstices may be left to allow of access of air to the surface of the lumps, in the same manner as in the case with ordinary lump coal; or else special means must be provided to retain and consume it in the furnace, and peculiar appliances be made use of to insure the passage of air through the fire-bed and its proper contact with the fuel. In either case provision must be made as far as possible for the prevention of the formation of large masses of clinker and the disposal of the ash.

The first method referred to, that of forming the coal waste into lumps of proper dimensions, by the admixture of clay or bituminous matter, or other cohesive material, can only be profitably employed when the cost of the operation is less than that of mining and preparing coal at the colliery.

Heretofore the largest proportion of the coal mined was from above the water level, and the comparatively low rate at which such coal was mined prevented the successful application of any processes for agglomeration.

As the coal above the water level is being exhausted and deep mining has become necessary, the increased cost has directed attention to the utilization of the waste coal under consideration.

A large investment of capital in machinery may bring the cost of manipulation below that of mining; but it is not likely that the run of the waste coal heap can be utilized by any such process, as it contains so large a proportion of foreign and incombustible material.

It is obvious that if the coal in its minutely sub-divided state can be advantageously consumed by means of any process or device which shall be moderately simple in its construction, and no more expensive of maintenance than an ordinary boiler furnace, the problem of utilization of coal waste will have been solved, and a very considerable economy in cost of fuel attained.

With this object in view, a method of consuming the material in question has been devised, and may be described as follows:

Air is injected into a closed ash-pan by means of a steam jet passing through one or more tubes. These tubes should be cylindrical, when volume of air without much intensity is sufficient; but when greater intensity is desired, as in the furnace of a locomotive, they should each be formed of two frustrums of cones, united at their smaller diameters; the proportions of the larger and smaller diameters varying with the degree of intensity of blast required.

The mingled air and vapor pass through a perforated fire-bed into the fuel in the furnace, and are thus evenly distributed through the fire, the fuel being spread over the fire-bed to a depth of about three inches.

The fuel upon the grate is gently lifted by the blast from over the perforations, the finer particles floating upon the current until the carbon is consumed; a large proportion of the ash passing off in a finely divided state, with the draft out of the stack.

The decomposition of the vapor in passing through the fire, results in the production of hydrogen and hydro-carbon gases, in addition to the carbonic oxide usually formed.

The blue flame of carbonic oxide is to a great extent replaced by that of the hydro-carbons and hydrogen, the combustion of this fuel resembling that of bituminous rather than anthracite coal; the flame extending occasionally to a distance of over twenty feet, instead of as many inches, as is the case in the combustion of carbonic oxide gas from ordinary anthracite coal burned in the usual manner.

The decomposition of the vapor causes a considerable reduction of temperature in the furnace. This cooling effect does not, however, result in a loss of heat, as the recombustion of the hydrogen derived from the decomposition of the vapor yields as much heat as was absorbed in its formation.

To insure the rapid and complete combustion of the fuel, and prevent the formation of solid masses of clinker, it should be repeatedly stirred upon the fire-bed with a rabble-shaped tool. This stirring process is an important element in the successful use of the fuel under consideration, as it serves to relieve the fire from the finely divided ash, which is thus exposed to and carried by the draught over the bridge-wall or through the flues of the boiler into the stack.

The perforated fire-bed forms an essential feature of the device, inasmuch as the loss of fuel through the grate during the stirring process is thereby greatly diminished, the average loss being less than two per cent. of the coal put into the furnace, whilst the weight of the fuel used for steam generation in stationary and locomotive boilers, is but slightly in excess of that which would be required of standard marketable sizes of prepared coal when burned in the same furnace with the ordinary bar grate in the usual manner.

The perforations in the plate of the fire-bed are made from three-eighths to three-fourths of an inch in diameter, and from two to three inches from centre to centre.

Wrought iron is preferred for making the perforated fire-beds, as that material admits of the use of a much thinner plate than cast iron, and consequently there is less liability to obstruction of the air-passages.

The exhaust blast of the locomotive is altogether unsuited to the consumption of the fuel under consideration, as by reason of its impulsive and vigorous lifting action, it is impossible to maintain the fire in the comparatively quiescent condition requisite for favorable results with anthracite coal dirt.

The usual method of urging the fire by means of the exhaust steam has therefore been entirely dispensed with, and instead of discharging the exhaust steam directly into the atmosphere, its heat is absorbed, as far as possible, by passing it through tubular feed water heaters before allowing it to escape.

By this means feed water is introduced to the boiler at a temperature in excess of 212° F.

A locomotive engine, using coal dirt exclusively for fuel, has recently been engaged in hauling coal trains over the Philadelphia and Reading Railroad, generating steam freely without the use of any portion of the exhaust steam as a draught-promoting agent, the substitute being a continuous supply of air and vapor, introduced into a closed ash-pan, as above described, aided by very small jets of live steam in the chimney for the purpose of facilitating the passage upwards of the products of combustion.

These results, obtained from many boilers now using the apparatus described, show that the hitherto neglected and apparently valueless material, known as coal dirt, can be profitably used for generating steam, and that hereafter it must be regarded as a fuel of great value.

The Polytechnic Review.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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ROBERT GRIMSHAW, PH. D., } EDITORS AND PROPRIETORS.

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THE LANGEN & OTTO GAS MOTOR.

In our February number we gave, as an introduction to a detailed description of an American gas-engine, a statement of the advantages of gas-motors as compared with the steam-engine. It may be desirable to give in this connection a *resumé* of these advantages before presenting the details of construction and operation of the Prussian engine at the Centennial Exposition, and illustrated herewith.

In choosing among the forces of nature for a motive power, the wind and the waves were first pressed into service; and not until comparatively recently has fire been employed, first, in connection with water as a moderating agent (in the steam-engine), later, in combination with air (as in some of the hot-air engines); the employment of flame itself directly acting upon the piston or other moving parts of the engine, having been the latest attempt of inventors. The advantages which the gas-motor offers over the steam-engine, where small power is needed, are its promptness of action, and the absence of the bulk, weight and danger of a boiler. The hot-air engine as commonly known, possesses, also, these advantages; but the weight and bulk of fuel in most instances, and the necessity and expense of constantly stoking and removing ashes, militate against the extended use of this motor. The explosive action of the mingled gas and air in the gas-engine has been a great drawback to its introduction, necessitating very heavy fly-wheels and working parts; while excessive heat, generated at once by confining the explosion, is directly communicated to the piston and cylinder, on account of the resistance of the driven parts to free and instant action of the piston.

In other words, if the full and instant force of the explosion be utilized at once and communicated to the piston as ordinarily connected with a crank, the spasmodic action produced cannot well be made available; while to resist and steady this spasmodic action involves the absorption by the piston and cylinder (to their great injury) of much heat which should be converted into useful mechanical work. The use of a constant and expansive flame only partly obviates this trouble, involving the use of a water-jacket, which generally wastes a large flow of water, and in any case is wasteful of the heat of combustion. The injection into the cylinder of a certain proportion of water, at each stroke of the explosion engine, had the effect of cooling the cylinder, and of somewhat increasing the power of the engine by the generation of steam.

An explosively acting gas-engine is in reality a gun, discharging shots whose force should be fully realized and converted into steady work. The "gunpowder pile-driver" is an instance in which explosive force is converted into work, and in which that explosive force would be fully utilized were it not that the bore of the gun is so short as to allow the gases to escape at a very high pressure. But in the gunpowder pile-driver the full recoil of the gun is at once realized and converted into work, and the force expended in driving the piston or shot to the top of the shears is all (less a trifle for friction) returned and used when that shot falls. The gunpowder pile-driver is, in fact, a single-acting explosive engine, with an "exhaust" of 500 lbs. pressure to the square inch.

If, now, it were possible (1) to exhaust at atmospheric pressure, (2) to prevent waste of force in a ruinous heating of the parts of the machine, and (3) to apply the explosive force to producing steady rotary motion, the gas-motor problem would be far towards a complete solution.

(1) To exhaust at a lower pressure, requires merely a lengthening of the gun. In the gunpowder engine the volume of the charge is increased by explosion from one to 2,000, hence the length of the stroke would have to be at least 2,000 times the depth of the charge. The substitution for gunpowder of a gaseous explosive, in which the products of explosion are but eleven times the volume of the charge, would necessitate a length of stroke but little more than eleven times the depth of the charge.

(2) To prevent the heating of piston and cylinder, the action of the explosive force upon the piston must be unimpeded. The full amount of force is then expended in the increase of volume of the gases, and the direct propulsion of the piston.

(3) To apply the great explosive force directly in actuating ordinary machinery, is impossible. To utilize *on the return stroke* the force of the explosion stored up in the piston, is possible, but necessitates a special mechanical adaptation for its accomplishment.

In other words, the following features should find place in an economical explosion engine: 1, a free piston; 2, great length of cylinder; 3, the entire abandonment of the crank (a device of itself, irregular in action and unsatisfactory in result, even in its use with a slow and steadily expanding motive agent, as steam).

The idea of the free piston is due to Mr. N. A. Otto. After many experiments and disappointments, he communicated his plans to Mr. Eugene Langen, and both worked together to overcome the difficulty in imparting to the shaft the motion of the piston-rod. Among their later devices was that of a toothed rack upon the piston-rod, and actuating gearing upon a friction wheel upon the shaft. The exceedingly short interval between the upward motion and the downward action, rendered the construction of the friction clutch one of great difficulty. The earliest device was a ratchet wheel and pawl. This was speedily abandoned. A rod with wedges gripping a belt between them and other wedges, was a second device. Later, was used an application of the simple friction device employed upon American sewing machines to prevent reverse motion—a rubber ball rolling freely in a wedge-shaped pocket against the periphery of the fly-wheel, but jamming tightly at the instant of reverse motion. The application of this principle to a friction clutch upon the driving shaft of Mr. Otto's engine, solved the problem of *application* of power. The economical *generation* and *conservation* of that power in the Otto & Langen engine, as well as its ingenious and efficient *application* by means of this friction clutch, and the devices for aspiration, explosion and exhaust, may best be understood from the accompanying diagrams:

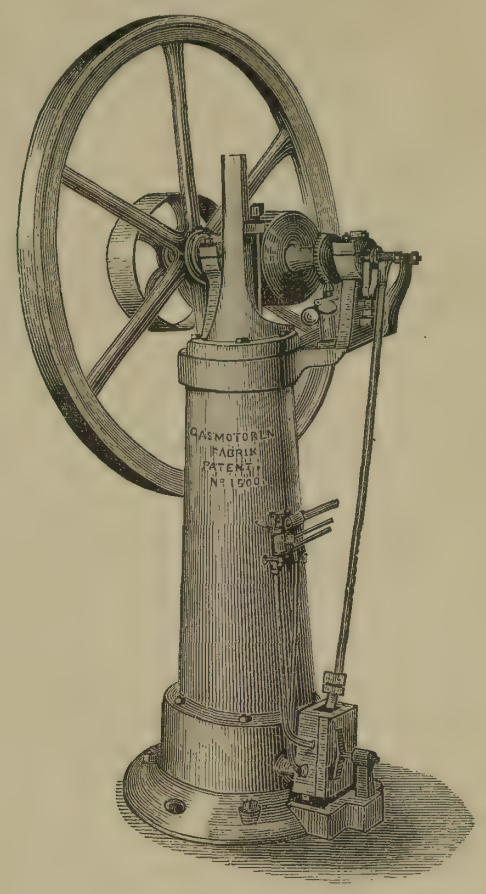


Fig. 1.

The engine is shown in elevation, in Fig. 1. Fig. 2 is a vertical section of the lower portion through the slide-valve. The piston *f*, being lifted about $\frac{1}{11}$ the length of stroke, gas and air are thereby drawn in through the channel *x*. The power to effect this movement is obtained from the momentum of the fly-wheel.

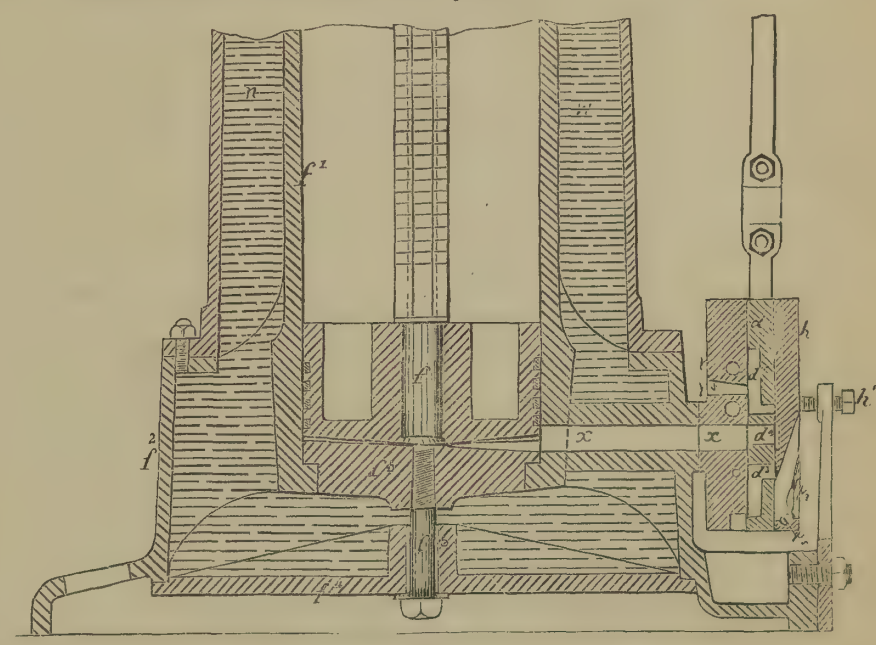


Fig. 2.

"On the igniting of the charge, the piston flies freely up to the top. As it ascends, the plenum caused by the explosion changes to a partial vacuum, reaching 22″ of mercury at the top of the stroke, and thus the motion of the piston is quickly reversed and the down-stroke is performed under a pressure of about 11 lbs. per square inch, derived from the atmosphere, this driving power being communicated through the rack and toothed wheel to the shaft. When the piston has reached within a given distance of the bottom, the vacuum, which has been gradually decreasing, is again changed to a plenum, and the weight of the piston and rack expels the burnt gases during the last few inches of the stroke, thus completing the cycle of operations."

The friction clutch used to connect and disconnect the piston-rod rack with the driving-shaft, is shown in detail in Fig. 3, which gives a partly sectional view of the upper portion of the engine, in a vertical plane at right angles with the section in Fig. 2, and with the shaft. There is a pulley keyed on the shaft and surrounded by a ring, on the interior of which are cut three inclined surfaces. On each of these inclined surfaces a set of live rollers is free to travel, and to press against a corresponding curved wedge while the piston is descending; and at the same time the opposite side of the wedge which is faced with leather, presses against the pulley. While the piston is ascending, no pressure is put on these wedges by the ring, and hence, in its up-stroke, the ring can freely revolve backwards upon its bearings on the shaft; but as soon as the down-stroke

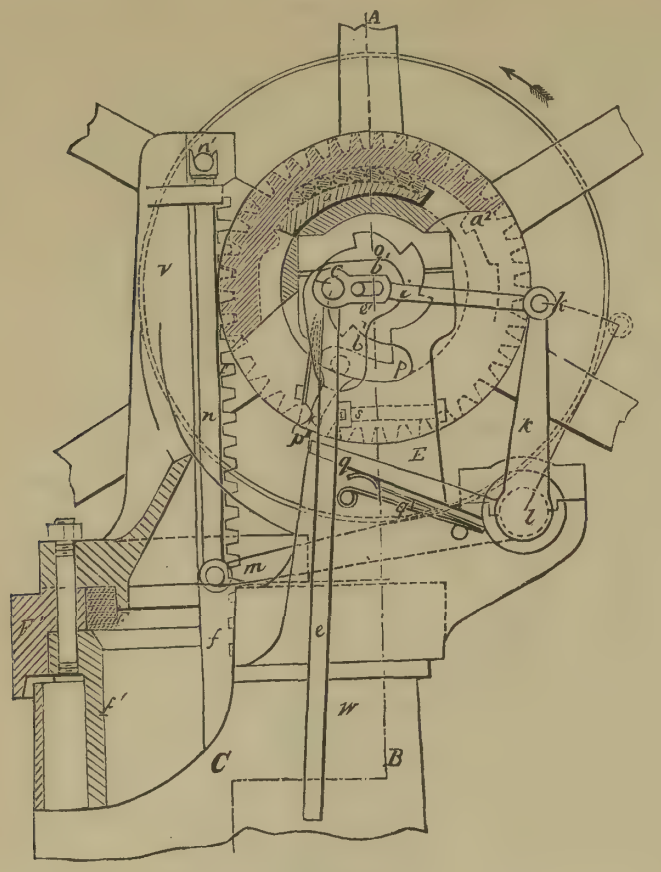


Fig. 3.

commences, a firm hold of the shaft is immediately gained by the ring, and the shaft thereby becomes connected direct with the toothed wheel which gears with the piston-rod rack. As by this means the piston is free to take any length of stroke within the limit of the cylinder, it is impossible to determine exactly at what moment it shall reach the bottom; and as the apparatus for lifting it to draw in the next charge is not required to move until the return of the piston, an intermittent motion is provided for lifting the piston, which is started at the right moment by a tappet fixed to the rack.

"The exhaust port being open during the entire down-stroke, there is a valve provided in the exhaust-pipe, preventing the atmosphere from entering the cylinder and destroying the vacuum, but yielding when the weight of the piston expels the burnt gases at the end of the stroke. By this arrangement the piston strokes would follow each other without any delay, if a common governor were not controlling a second stop, keeping the pawl P from falling into gear with the ratchet-wheel, moving the slide-valve, and aspiring gas into the cylinder.

"This is one of the most important features of the engine. To take an example of its effect, suppose an engine is employed in hoisting, and that the load demands the exertion of its full power to accomplish the work; in this case the governor will never stop the intermittent motion of the valve-gear, and explosions will take place as rapidly as possible—say 30 per minute—while the load is being raised. Now, suppose that the load gets to the top, and the work is suddenly thrown off, the effect of this will be to increase the speed of the engine sufficiently to cause the governor to stop the pawl; and until the governor descends again by the speed dropping, the engine will not make another stroke or explosion. In some of the best of these engines there will be a pause of a minute before this takes place; or in other words, only 1-30th of the power of the engine is required to move itself whilst doing no work."

The igniting of the gases is performed by the slide-valve and two lighting jets, burning one before the other, in the valve itself, in the excavation d^3. By the motion of the valve the space d^3 first goes down and ignites its contents (gas and air), at the flame burning continually before the valve, then comes up to x, where it ignites the charge.

It may be interesting to mention that this gas-engine may be considered as a new

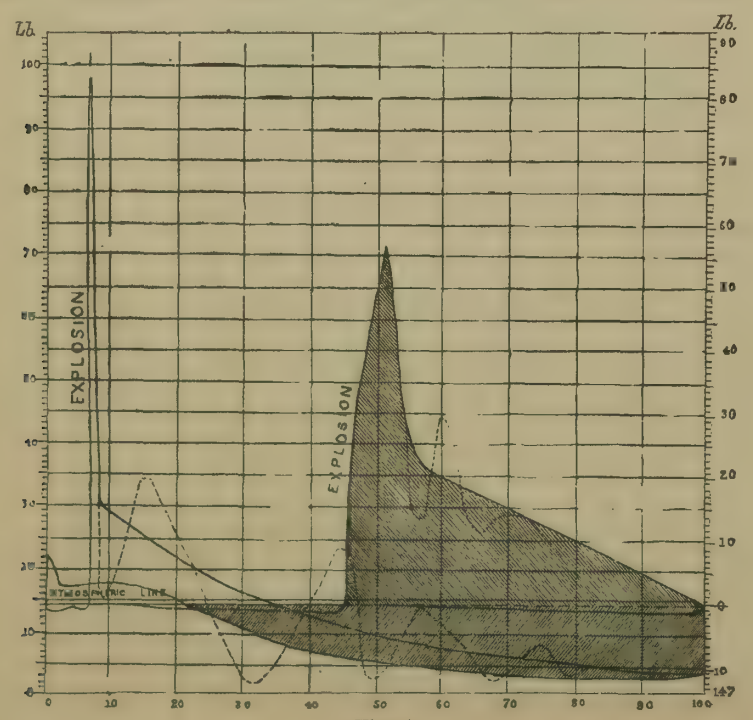


Fig. 4.

form of steam-engine, inasmuch as the chief result of gas combustion is nothing but steam expanding from 2000° F. down to 150° F. The high pressure giving the upward motion to the piston is not lost, but the speed of the piston makes it fly much higher (see left-hand diagram, Fig. 4) than the atmospheric line, and, by forming a partial vacuum, the decrease of temperature condenses the steam.

The right hand diagram was taken from a horizontal gas-engine acting by direct force of explosion. Nearly half the out-stroke is occupied in drawing in the charge, the return stroke being an open exhaust.

The Langen & Otto engine has the demerit of being noisy, and of requiring a very large cylinder. It has this great merit, that the governor may stop the motion of all the parts except the fly-wheel and shaft. It starts with full power at a moment's notice; uses no fuel when not running, and but little when exerting only power enough to effect the regular rotation of the fly-wheel; requires but trifling attendance; gives no trouble with coal or ashes; requires very little water; is free from danger, and does not affect insurances.

The consumption of gas, indicated by Professor Tresca, in 1870, on an engine of 0.86 H. P., was 40.1 cubic feet per hour per indicated H. P., including 2 cubic feet by the lighting-jets. At present, the consumption of gas is stated to be but 26.5 cubic feet per H. P. per hour. The cost in Philadelphia would, for this consumption, be 5.7 cents per H. P. per hour. A small steam-engine, requiring 18 lbs. of coal per H. P. per hour, would cost about 6 cents for the same power, if run continuously.

Using pure hydrogen, two-fifths the theoretical efficiency of the fuel might be realized on the brake. With 1 volume of coal-gas and 6½ of air, a consumption of 1.05 cubic feet of gas per minute should give, theoretically, 584,000 foot lbs., of which the brake shows 12 per cent. The very best steam-engine, consuming 2 lbs. of coal per H. P. per hour, uses 23,505,856 theoretical foot lbs., and gives out but 1,980,000 foot lbs., or only 8½ per cent.

The patentees' agents in America are the Messrs. Schleicher Bros., 119 South Fourth street, Philadelphia. †

REPORT ON THE COMPRESSIVE STRENGTH, SPECIFIC GRAVITY, AND RATIO OF ABSORPTION OF THE BUILDING-STONES OF THE UNITED STATES IN MOST GENERAL USE.

BY LIEUT.-COL. Q. A. GILLMORE, CORPS OF ENGINEERS.

[*Abstracts and Abridgment.*]

For the softest Massillon sandstone, crushing at about 6000 lbs. with steel, we find the wood cushions giving results about 20 per cent. higher than those of steel. One of the four results with steel plates, however, shows so much discrepancy, compared with the three others, that it may be rejected, and we may safely put steel and wood at 100 per cent. each, lead at 90 per cent., and leather at 60 per cent. Here the difference between the lead and the leather evidently results from their relative softness, the lead evidently beginning to flow at a pressure of about 5,400 lbs. per square inch, while the leather probably begins at near 3,600 lbs. For the Massillon sandstone, crushing at 8000 lbs. with steel, we again find only a slight difference between steel and wood cushions; but here appears to be another boundary, where the lead plates again take their position at 85 per cent. (or half-way toward the normal amount at high pressure, 65 per cent.), which seems to commence at about 7,500 lbs. per square inch, whence it remains constant to at least 25,000 lbs. per square inch for steel, or 16,250 lbs. for the lead itself.

With Berea sandstone, Table III, we have the lowest results of the general average, steel giving 11,000 lbs. per square inch, crushing strength; wood, 10,000 lbs.; lead, 7,500 lbs.; and leather, 6,700 lbs., the percentage being as follows: steel, 100; wood, 91; lead, 65; and leather, 60. Down to these points, then, our deduced averages, taken from the table, are sufficiently accurate for practical work; and below these points, that is, among the softer and weaker stones, the peculiarities of the pressing surfaces are not developed, and we get about the same results, whether we use wood, steel, lead or leather.

It seems probable that the real cause of the divergent results obtained with the harder and stronger stones, lies in the relations existing between their tensile and compressive resistances, and that the law under which those divergences are disclosed, will be expressed in functions of those relations. The properties of tensile strength, compressive strength and hardness, though common to all varieties of rock, vary in their relation to each other among the different kinds, within measurable and sometimes within comparatively wide limits.

It is practically known among builders that a stone may be very hard and yet very inferior to another which is softer, if it is to be placed where any tensile or beam strain will come upon it. The subject will be further discussed in this connection after all the experiments, others of which bear some relation to it, shall have been described.

TABLE IV.

Showing the resistance of prisms of blue Berea sandstone, having different heights in relation to widths of bed, and broken under steel, wood, lead and leather. The table is divided for convenience of reference in discussion. The specimens were all taken from one block.

Broken between steel cushions.	2×2×1 in.	2×2×2 in.	2×2×4 in.	1½×1½×¾ in.	1½×1½×1½ in.	1½×1½×4 in.
Average.....	75,888	49,137	43,980	34,643	25,350	22,432

Broken between wood cushions.	2×2×1 in.	2×2×2 in.	2×2×4 in.	2×2×6 in.
Averages.....	45,571	43,857	37,160	38,028

Slabs, 2×2×1 inch.	STEEL.	WOOD.	LEAD.	LEATHER.
Averages.....	69,550	47,250	30,750	21,430
Percentage.....	100	67.9	44.2	30.8

Other experiments were made, and appear in Table IV, regarding the difference between the resisting powers of stone—in this instance confined to one kind—at one-half once, twice and three times the bed-diameter in height. These, curiously enough, conform precisely to the specific experiments made by Mr. Hodgkinson, and probably point to his further correctness in cases where the width of base is still less in proportion to the height. It will be obvious, however, from the number and completeness of these trials, that the general principle which he seeks to establish—namely, that the compressive resistance of rectangular blocks, when crushed between plates by a vertical force, is proportional to the horizontal area of the blocks—is entirely incorrect when the height is near or less than the bed-diameter. Results in this connection are more elaborately worked out in the two sets of experiments on the breakage of different-sized cubes, with which this section concludes.

Fig. 3.

With blocks having different relative heights, the difference in the manner of breakage is very observable. Those in which the height is one-half the width of bed are in all cases simply crushed to powder under steel and wood, and are more inclined to split in fine splinters, which easily become powder under lead and leather. Cubes break, as has been before described, into solid fragments under steel and wood, and under lead and leather split into as nearly a fibrous condition as is possible with stone.

Stones having a greater height than width of bed, are partly split into large prisms by wood and steel, but more characteristically are broken across their heights in an oblique plane, precisely as wood yields when having greater height than diameter, it is pressed in a direction parallel with the fibre, as shown in Fig. 3. None of these latter were tried with either lead or leather.

The experiments recorded in Table V were made on beams of stone 2 inches cross-section and 6 inches long, broken on supports 2½ inches apart, the bed being upon a long side, and receiving the pressure normally. They were not quite satisfactory because the first record was only approximately deduced, and because there were no specimens of the more fragile Vermont marble broken. These beams had partially flexible supports under them, made of soft pine, extending from the end 1¾ inches toward the centre. A wrought-iron cylindrical rod, ½ inch in diameter, was laid across the top centre, and the power applied to it. The results were as follows:

TABLE V.

Beams 2×2×6 inches; bed 6×2 inches, resting on pine blocks, and broken by wrought iron cylinder ½ inch diameter across centre; supports 2½ inches apart.

GRANITE. Millstone Point, Conn.	MARBLE. East Chester.	GRANITE. Keene, N. H.
4,000 to 4,500	4,000 to 4,200	3,300

Records not fully satisfactory, but sufficiently approximate for relative results. The East Chester marble and Keene, N. H., granite records can both be relied on; those of the Millstone Point granite cannot.

From the known fragility of the Vermont marble in comparison, it could not have stood over 2,500, or, at most, 3,000 lbs. Accepting the larger number hypothetically, we should have Millstone granite, 100; East Chester marble, 100; Keene (N. H.) granite, 77; Vermont marble, 75, as the relative beam strength of the stones compressed with steel, wood, lead, and partially with leather, in the first part of these discussions.

TABLE VI.

Showing the difference in resisting power between stones broken with wood cushions—when their beds are polished—and stones with the same pressing surface when only worked to clear beds.

KIND OF STONE.	POLISHED.	UNPOLISHED.
GRANITE:		
Quincy, Mass	99,000	71,000
Staten Island, N. Y.	100,000	89,000
Garrison's, N. Y.	86,500	53,500
Tarrytown, N. Y	95,000	73,000
Millstone Point, Conn	91,500	75,000
Keene, N. H	79,333	51,000
Westerly, R. I	94,000	71,000
Difference 25 per cent. (nearly).	645,333	483,500
MARBLE:		
East Chester, N. Y	70,156	51,800
Vermont marble, Vt	43,400	35,000
Difference 25 per cent. (nearly).	113,556	86,800

The special experiments, Table III, with the different mediums of communicating the pressure—viz., steel, wood, lead and leather—were made with stones in a fairly polished condition, when polishable stones like granite and marble were used. The sandstones were rubbed to a fine smooth surface. Now, inasmuch as the general tables were prepared with stones that were not polished, and many of which were incapable of receiving a polish, though all were carefully dressed to a smooth and even surface, and crushed between disks of pine wood, some variations of results were to be apprehended from differences in the condition of the surfaces of the cubes to which the power was applied, even though the same compressing medium was employed.

DUST-FUEL IN THE CUPOLA.

In the last issue of the REVIEW (page 37) a brief allusion was made to certain interesting metallurgical improvements of Mr. William Batty, involving, amongst other things, the employment of dust-fuel in the melting of iron. Since the appearance of the item in question, the opportunity of making a further investigation into the theoretical and practical advantages to be derived therefrom has been accorded, the results of which will appear in what follows. It may be well to preface our remarks with the statement that the introduction into furnaces of various kinds of coal in pulverulent form through the tuyeres is, to the best of our belief, not a novelty, having been patented years ago and employed in practice, if we mistake not, both here and abroad, though with what success we are not at present prepared to speak advisedly. The attention of metallurgists has lately been attracted to the subject by the announcement, in a leading journal devoted to the iron interests, that the use of pulverized coal in the cupola had been introduced with most satisfactory results at the Edgar Thompson Steel Works, and as the statements presented in our esteemed contemporary have a direct bearing upon the subject matter of the present article, we deem it proper to refer our readers to the communications in question (*vide American Manufacturer*, February 24th and March 23d, 1876) without comment.

The object sought to be attained by the introduction of powdered carbon blown in at the tuyeres of the cupola, or blast furnace, is to neutralize the decarbonizing effects of the excess of oxygen that is usually forced in for the purpose of melting the iron or ore. It is well known to practical foundrymen that the larger the quantity of iron to be melted the more difficult it is to preserve clear tuyeres and hot iron at the end of the heat. This difficulty is largely due, as appears most probable, to the continued chilling produced by the excess of oxygen over the carbon of the fuel, which allows the slag to become tougher and more sluggish, and to set over and around the tuyeres, sometimes stopping them up entirely, producing scaffolding and an uneven distribution of the blast. But this is not the most important of the evils experienced by the iron founder. The iron melted in the cupola is decarbonized, thus becoming harder each time it is melted. So decided is this oxidizing effect, that really a cleaner iron, so far as silicon, sulphur, &c., are concerned, can be bought for nearly one-half the price, in the shape of scrap, that it cost while in the pig. To obviate these, and other minor difficulties, has been the purpose of those who have suggested or applied the use of powdered coal with the blast, in the manner before alluded to; and these explanations bring us to the main purpose of our remarks, namely, the improvements of Mr. Batty.

Some twenty years ago Mr. Batty applied in practice the observation that the deposit of gas-carbon lining the retorts—a residual product incidental to the manufacture of illuminating gas—and more recently, the residual carbon incidental to the process of refining petroleum, were almost absolutely free from impurity. Unlike anthracite or bituminous coal, or even the best coke, these products may be completely consumed, when supplied with the necessary quantum of oxygen, leaving behind practically no residue or ash.

Appreciating the nature and cause of the difficulties named at the outset of this article, Mr. Batty adopted the plan of making the air-supply itself carry along with it that which, when it reached the melting zone, should not only neutralize the oxidizing tendency of the blast, but also realize therefrom other incidental advantages. The points of practical value peculiar to this process, properly carried out to realize the theoretical advantages of which it is capable, may be stated as follows: 1st. Every atom of oxygen, immediately it enters the zone of the tuyeres, has present an atom of carbon with which to unite; hence, a more intense neutral flame directly at the zone of fusion; and as the supply of carbon is entirely under the control of the operator, the quantity of carbon may be regulated to suit the requirements of the case. 2d. The iron is made hotter by the intense heat attained, and instead of suffering oxidation by passing through carbonic acid and free oxygen, it falls through carbonic-oxide and incandescent carbon particles, carbonizing itself sufficiently to perceptibly influence the quality of the castings when cold. 3d. The slag at this high temperature is limpid and runs freely down to the surface of the iron, the blast having lost its chilling properties. 4th. Scaffolding is simply impossible. 5th. The productive capacity of the furnace is notably increased, and incidentally the waste of metal avoided. By this process, therefore, it is not affirming too much to say that good selected scrap should make a better casting than pig; for having parted with most of its sulphur, &c. (and some of its carbon), in the previous melting, it is recarbonized, but neither sulphur or other mineral impurity is introduced by the fuel employed—as would be the case if pulverized coal or slack were used—it should make a cleaner and more reliable casting, smooth and close in the grain, having the two desirable properties of toughness and softness.

From the foregoing, it will be inferred that the process described is applicable with advantage, and will be of great value in all cupolas for melting iron for castings; and, as remarked in our last, is worthy of particular notice, inasmuch as it affords an excellent means of economically utilizing refractory scrap and the many varieties of waste and refuse iron. Mr. Batty's process, as there noted, has been in constant operation in Philadelphia, under his own supervision, for a considerable time, working up tin-scrap, old roofing, &c., and is now about being introduced into one of the largest foundries in this city. We shall seize the opportunity to note from time to time any fresh developments in this direction. *

DIFFERENT INDENTATIONS ON IRON AND STEEL.

The fibrous character of forged iron and steel is an essential element of its strength when exposed to torsion, or to extension by longitudinal strain. It is important, therefore, that the continuity of the fibres should be as little disturbed as may be in fashioning these materials for places where they will be subjected to these strains. It has become the practice with all good workers to forge to gauge, so that but little is left for the machinist to do—merely a light chip in the lathe or planer being sufficient to make a fit. Car-axles, crank-pins, journals, &c., are generally forged almost to finish-size, and the sides of the bearings made curved instead of having a square offset. By this means the fibres are not ruptured nor cut through, but merely bent or deflected from a right line. When, however, it is necessary to cut these fibres, it appears to be a matter of considerable importance what is the form of the indentation if the element of strength is to be taken into account. If a bar is turned in the lathe with a V-shaped tool, making one complete cut around it, the bar may be broken with much less force than if a cut of the same depth is made with a round-nosed tool; and when a square-nosed tool is used, the fracture, when the bar is broken, will be sure to occur at one of the corners, and not in the centre of a cut. Several theories have been suggested to account for these differences: some of the hypotheses appear plausible, but none of them have been demonstrated. The facts, however, remain undisputed. In the case of a blow, as from the edge of a chisel, a concentration of the vibration at that point may have the effect of injuring the cohesiveness of the fibres to a depth much below the apparent depth of the cut; but this theory is not applicable to the conditions of the lathe trial. L.

PROGRESS IN SCIENCE AND THE ARTS.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—The 192d meeting of the Society of Arts, was held March 9.

RIFLING HEAVY GUNS.

Professor E. L. Zalinski, U. S. A., read a paper, illustrated by numerous diagrams and models, on a new system for rifling heavy guns, devised by Mr. S. P. Ruggles, well known as the inventor of many useful and ingenious mechanical devices.

The following are extracts from his paper:

Before mentioning the details of Mr. Ruggles' plan, and the arguments upon which they are based, I will briefly sketch—first, the object of rifling guns; second, the various kinds of rifled projectiles; third, the principal modes of rifling in use at the present time; fourth, some of the arguments used by the advocates of the uniform and variable pitch or twist of rifling.

Mr. Ruggles' plan of rifling cannon, and projectiles to be used therewith, was shown by a model, on a scale of 1″ to 1′, the bore being 12″ long and .25″ in diameter. It contains sixteen grooves of a serrated shape. The grooves used in United States cannon are rectangular, similar to those of square-threaded screws. Mr. Ruggles claims that this is unnecessary, as only *one* side of the groove is subjected to any strain or bearing in firing; that, whilst in the screw, it is necessary to have bearings on *both* sides in order to move it forward and *back*, in a gun the rotary motion is required only whilst the projectile is moving *forward* out of it. In consequence of this, twice the number of serrated grooves, each having the same effective bearing surface as the rectangular groove, can be cut in the bore, doubling thereby the effective bearing surface, without weakening the gun; the depth of these can be reduced by one-half if the former amount of bearing surface was considered sufficient, and weaken the gun less than by the service method.

The projectile has an expansive sabot of soft metal to be forced into the grooves by the powder-gas, and thus give the required rotary motion. From this kind of groove the sabot is enabled to expand, fitting closely to the surface of the bore at every point, utilizing the entire force of the powder-gas and preventing its escape (which is not the case with the service groove). The results attained with a given weight of powder will be more uniform than when a large amount of gas is permitted to escape, as in the service groove. This model exhibited the difference of windage of the two systems of grooves.

Around the front of the projectile, near the junction of the cylindrical and conical portions, is a soft metal hoop, which is to be expanded by the powder-gas that must pass the base sabot at the first moment of the explosion; this will cause it to expand sufficiently to *centre* the front end of the projectile, although it may not have filled the grooves. The band is put on loosely, so that it may turn. The object of this will be seen hereafter.

A great variety of opinion exists as to the rate and kind of twist which should be given to rifling. There are two kinds of twist used—"uniform" and "varying."

The uniform twist is one which imparts the required rotary velocity upon starting the projectile. The increasing variable twist is one which causes the projectile to move straight forward at first, and then gradually acquire its ultimate rotary velocity at the muzzle.

Mr. Ruggles proposes to use an increasing twist, and considers that one based upon the law of gravitation will give the best results. By an ingenious device he has made the twist on this cylinder an exact copy of the law, as to progressive increments of pitch, giving the projectile one revolution in travelling the first 48′ of its flight.

By his device of a loose collar around the front of the projectile, Mr. Ruggles meets one of the objections to the use of the variable twist. If this were held fast to the projectile, there would be a tendency for the front and rear of the projectile to have difierent rotary velocities. One or the other would have to "slip," and additional friction and resistance would result therefrom.

Mr. Ruggles claims: First, that his peculiar increase of twist is the only true form that can be adopted; that the projectile begins to receive its rotary motion at the same time that it begins to move longitudinally, slowly at first and with an increasing speed corresponding to that of a ball starting from a state of rest and falling to the earth by gravitation. Second, that the gun will be weakened only half as much as by the service mode, and that there will be just double the number of projections to rotate the ball. Third, that the hoop or soft metal around its forward end centres the projectile and prevents its chafing the bore of the gun in its passage out. Fourth, that by the peculiar shape of the rifling, the sabot is enabled to fill perfectly all the grooves, and to prevent all escape of powder-gas.

It was thought by some that the great increase of twist near the muzzle of the gun, as seen by the model, would strip or increase the strain of the gun; but Mr. Ruggles is prepared to prove that such is not the case.

After interesting remarks by several experts in the science of gunnery and projectiles, the meeting was dissolved.

The 193d meeting, March 23.—

Voted:—That a committee prepare resolutions favoring a congressional appropriation to complete the experiments upon various metals contemplated by the United States commission for that purpose.

Prof. Channing Whitaker read a paper on some

NEW DEVELOPMENTS IN STEAM ENGINEERING.

De Pambour thought that saturated steam expanding in a cylinder followed the laws of Mariotte and Gay Lussac; that it remained saturated during expansion, and that the weight of steam present in the cylinder was constant throughout expansion. We now know that these ideas are not consistent. De Pambour's views were, formerly, generally accepted; and many practical engineers to-day refer to Mariotte's law as representing the expansion of steam in a theoretically perfect engine. That law is, that the pressure is inversely proportional to the volume; $pv = pv = constant$; in which p = the pressure, and v = the volume of the steam. The curve representing Mariotte's law is easily drawn. The axes of co-ordinates are rectangular. Vertical distances represent pressures, and horizontal distances represent volumes, as upon an indicator diagram. As the volume doubles, the pressure reduces to one-half.

Regnault's experiments have given us most of the facts upon which our knowledge of the laws of steam is based. Both Rankine and Zeuner calculated with Regnault's data the volume occupied by a unit of saturated steam under different pressures. Had their results been absolutely true, we should have been able to draw the expansion line which would be produced if the steam in the cylinder was always saturated and did not vary in weight. The curve calculated by Zeuner is practically $\frac{pv^n = pv^n = \text{constant}}{n \text{ being } 1.06462}$.

Fortunately, Fairbairn and Tate have given us experimental results confirming as closely as could be expected the calculations of Rankine and Zeuner. The curve F represents their experiments, and has been plotted according to their empirical formula—$v = 25.62 \text{ plus } \frac{49{,}513}{p \text{ plus } 0.72}$, in which v is the steam volume, and p the total pressure in inches of mercury.

By comparing F with M, we see that, commencing to expand with the same pressure and volume, the pressures belonging to F fall below those belonging to M. This shows the inconsistency of De Pambour's belief that the curve of Mariotte was also that of a constant weight of saturated steam.

The curve F is an important departure from Mariotte's. I have calculated the value of n for the curve F, on the supposition that $pv^n = pv^n = constant$, and I find that the facts cannot be expressed by that formula.

Rumford first determined, experimentally, the mechanical equivalent of heat. Tate has deduced, from the results of his experiments, a value for that equivalent, which is but 20 per cent. too great; remarkable, considering the knowledge of his time.

The credit for having determined the now universally accepted value of the mechanical equivalent of heat—*i. e.* 772 foot lbs.—is due to Dr. Joule. Shortly after the announcement of Joule's experimental determinations, Rankine and Clausius drew from it, and from Regnault's experiments, a very interesting conclusion. They found that if no heat were communicated to the steam during expansion, it would be obliged to give up heat during expansion, in order to produce the work done during expansion. Some of the steam would be condensed during expansion, and instead of the expansion line being a curve of a *constant* weight of saturated vapor, they believed it to be a curve of a *constantly decreasing* weight of vapor. Zeuner called this an adiabatic curve. Zeuner says this discovery is one of the most remarkable to which the mechanical theory of heat has led, and that it is time the old theory of steam engines should be suspended.

Rankine gave the following approximate formula for this adiabatic curve: $pv^n = constant$; n being 10.9, or 1.11111. Rankine's high reputation has led many practical as well as scientific men to take it for granted that this adiabatic line is that along which steam should expand in a theoretically perfect engine. No doubt the mathematical entanglement surrounding the subject has hindered many from getting at the *rationale* of it.

Zeuner concludes that if he has dry saturated steam at the beginning, he will have different values of n, according to whether expansion begins from a high or a low pressure, or the steam is expanded much or little. But, beginning with dry saturated steam, the value 1.135 is near enough. He concludes further that if, at the beginning, the steam was mixed with .10 of water by weight, n would equal 1.125; if .20 of water, n would equal 1.115; if .30 of water, n would equal 1.103.

It is supposed that the steam neither receives heat from nor imparts heat to any other substance during expansion, but that as much as is necessary for the purpose is converted into the work done during expansion. The heat converted into this work is then obtained from the expanding steam, and a portion of it is therefore condensed, and the curve is therefore one of a decreasing quantity of saturated vapor.

I now venture to state that, accurate and interesting as is the mathematical process by which the nature of the adiabatic curve has become known, it is still by no means certain that steam in a cylinder should be expected to expand along an adiabatic curve. The supposition that it neither receives heat from nor imparts it to any other substance during expansion, is untenable.

Both scientific and practical men are deeply indebted to Rankine, and Clausius, and Zeuner for light upon intricate thermodynamic questions. But when it was known that this steam in a cylinder would expand along an adiabatic curve only in case no heat, as heat, should be added to or subtracted from it during the process, it should not have been concluded so hastily that steam expanding in the cylinder of an ordinary engine conformed to this. If it was difficult to observe directly the temperature of the steam in the cylinder for the purpose of proving this premise, we should have compared the adiabatic curve with the expansion curve of numerous indicator diagrams. If these agreed with the adiabatic curve, we should grow more confident that the ordinary conditions were those of the adiabatic. But if we found divergence, we should form a different opinion.

I have said that the adiabatic curve is one of a *constantly decreasing* weight of steam, and approximately expressed by $pv^n = constant$: n being 1.135, if the steam be dry at the beginning. The curve of a *constant* weight of steam can be approximately expressed by the same formula, if n be reduced to 1.0646; and Mariotte's curve can be expressed by the same formula, if n be still further reduced to unity. It is readily seen that Mariotte's curve is one of a *constantly increasing* weight of steam, and the smaller the exponent n in the formula, the more rapid the increase in the weight of steam during expansion.

I believe that the conditions of ordinary expansion are not those of the adiabatic curve, and that engineers made progress backwards when they substituted it for that of Mariotte.

In almost all cases, diagrams taken from unjacketed engines using saturated steam expansively, show a *greater increase* in the weight of steam during expansion than if the steam had expanded along a Mariotte's curve; for when a Mariotte curve is drawn through the point of release it almost always lies wholly above the expansion line.

Mr. James H. Head examined the expansion curves of various indicator diagrams. The results of his examination will be best understood through an abstract of his graduating thesis: "Professor Rankine states that the coefficient of expansion of dry saturated steam in an unjacketed cylinder, is 10 9; in a jacketed cylinder, 17-16. That is, pv 10-9 = constant and pv 17-16 = constant, when p represents the absolute pressure, and v the volume of the steam. These values were determined by calculations based on theoretical deductions from the known nature of steam and work, and not by experiment.

"This investigation was to ascertain whether the values calculated by Rankine agreed with the results of experiment with ordinary steam in ordinary engines; for it was believed that the effect of an important influence was overlooked in his calculations. Twenty-five or thirty sets of indicator cards taken from different engines having unjacketed cylinders were examined. Generally, saturated, but sometimes superheated, steam was used. No data were obtained from jacketed cylinders.

"As far as this investigation goes, it appears that the coefficient of expansion given by Rankine for unjacketed cylinders is incorrect for practical usage. For, first—The law expressing the relation of pressure to volume, when either saturated or superheated steam is expanding in an ordinary unjacketed steam cylinder is not necessarily pv^n = constant. Only in the case of one or two expansion curves could the relation be approximately expressed by that form.

"Second—On expressing the relation approximately by the form pv^n = constant, I find the coefficient n is not constant; that it varies in different engines, and even in the same engine, if the point of cut-off be changed. I found it to vary from .65625 to 1.0200. These extremes were derived from saturated steam diagrams taken from the front end of a Harris-Corliss

engine, cylinder 8.01″ in diameter, 24″ stroke." "The coefficient .65625 was derived from diagrams taken with an apparent cut-off of $\frac{1}{18}$; steam pressure, 71 lbs.; speed, 57 revolutions. The coefficient 1.02 was derived from diagrams taken with a real cut-off of about $\frac{3}{4}$; steam pressure, 70 lbs.; revolutions, about 59."

Two principal reasons have been assigned for the increase in the weight of steam in the cylinder during expansion: First—Leakage of steam. Second—The re-evaporation of water which entered as steam and condensed against the cool walls during the early part of the stroke; the re-evaporation being produced by heat returned to the steam, during expansion, by the walls of the cylinder. The leakage past the piston-packing and exhaust-valve should, in most cases, at least equal that past the steam-valve. In other words, it seems reasonable to suppose that in most cases at least as much steam will leak out of as into the cylinder, during expansion.

There are many reasons why I think it more likely that the results are rather due to condensation and re-evaporation. I cannot help suspecting that speculative thinkers are indirectly responsible for some of the blunders in engineering, which are made by their disciples, and which cost the public hundreds of thousands of dollars annually.

Had the schools paid more attention to the *facts* which relate to the *economics* of steam engineering, less coal would have been burned in the production of power, and less capital invested in expensive engines.

The 194th meeting of the Society of Arts, April 6.—

Dr. Ephraim Cutter exhibited and explained an invalid chair of his invention.

PHOTOGRAPHS OF MAMMALIAN BLOOD.

Dr. Cutter then exhibited micro-photographs of the blood of man and of some of the higher animals, taken by himself.

His object was to ascertain what ground, if any, medico-legal experts had for saying that they could distinguish the blood of a child from that of an adult, or that of man from any other mammal. He had such photographs taken by the aid of a microscope, transferred to glass positives, and then thrown on a screen with the calcium light. The images can thus be measured either directly or by the eye, and any observer, not a microscopist, can determine for himself whether such discrimination is possible, as size is the only morphological element of the red blood corpuscle taken into account by such experts.

He exhibited the blood of man, rat, dog, pig, ox, deer, squirrel, sheep, horse, mouse, cat, rabbit, frog and trout—all taken with the same 1-50 objective, at a distance of twenty-six inches, and reduced upon the glass positives at the same distance from the camera.

Before showing the pictures he described the manner of taking them, as to articles employed, objectives, stand, slides, camera, and position of the various parts of the apparatus, and also the difficulties arising from the shaking of the building by the travel in the street, from focussing, and the arrangement of the light.

The averages of the measurements were as follows:

Man	1-3100 to 1-3200	of an inch.
Dog	1-3200	" "
Squirrel	1-3600	" "
Rat and Rabbit	1-3400	" "
Deer	1-3500	" "
Ox	1-3900	" "
Pig	1-4028	" "
Horse	1-4200	" "
Sheep	1-5600	" "

Other observers differ from the above measurements of Dr. Harriman, but always in a slight degree; and Dr. Woodward could not find any difference between those of man and the dog. Whether such small differences could be of any value in legal medicine he left for his audience to determine, showing, as he did, that in the same specimen the size varies considerably, and that, familiar as he was with the appearances, he could not at a glance distinguish them. He also exhibited the appearance presented by diseased blood, in the various stages of consumption, showing very interesting and characteristic changes in the outlines, appearance and contents of the globules.

Mr. S. Dana Hayes complimented Dr. Cutter on the successful results he had obtained in this difficult line of investigation. He exhibited some photographs by Dr. Wormley, in which two bloods, that of man and that of the dog, were shown, each occupying one half of the field—an admirable way of exhibiting the contrast, and remarkable for the evenness of the distribution, the distinctness of form and outline, and the comparatively low power with which they were taken. He described the probable way in which these were prepared, and stated that there was no reason why four bloods could not thus be exhibited at the same time, a comparison which might have its value in legal medicine.

A NEW FORM OF WINDMILL.

Mr. H. P. Langley read a paper on "Aerial Motors or Windmills, and Some of the Wasted Forces of Nature;" and explained a windmill of his construction."

ST. LOUIS ACADEMY OF SCIENCES, *March* 20.

President Riley in the chair.

Prof. Potter reported that Dr. G. I. Engelmann and himself had visited the New Madrid mound region during the past week. They opened four mounds, secured ten or twelve skulls and about one hundred specimens of pottery. They also made a survey of the locality, and will soon submit a more extended report.

G. C. Broadhead read a paper on the Porphyritic rocks of south-eastern Missouri, elucidating the evidence that these rocks are Huronian. This paper was referred to the publication committee.

A. J. Conant read a paper on the mounds of New Madrid. The burial mound examined by him was found within an enclosure of about fifty acres, which is surrounded by earthen walls. Probably a thousand skeletons have been already found. Three pieces of pottery are usually found with each skeleton. Some vessels were more than a foot in diameter, with walls so thin they could not have been safely moved when filled with water. It was observed that some skeletons were in a much better state of preservation than others. In some cases the outline of the skull was only shown by a thin white line. In other cases the usual pieces of pottery were found, but all traces of the skeleton had disappeared. Mr. Conant thought this an evidence that the mounds had long been a place of burial. Mr Conant's paper was referred to the publication committee.

Dr. George Engelmann made a communication on North American oaks. The genus *Quercus* is more extensively developed in America than in any part of the world. In the Carolinas, oaks grow as small shrubs. The leaves of different oaks show great variations, some resembling the leaves of the willow, others that of the holly, &c.; but the fruit is very much the same in all. The typical, and probably the primitive oak of the Tertiary, had an acorn and a lobed leaf. An oak found in California has a flower and leaves like a chestnut, but bears acorns like an oak. The cup of the acorn, however, is spiny like the burr of the chestnut. Dr. Engelmann remarked that this oak may be a hybrid produced between the chestnut and oak in bygone times when these genera were less differentiated, as it is well known that even now hybrid oaks will propagate when removed from the "struggle for existence" against more hardy rivals.

April 3.—President Riley in the chair.

Prof. Potter, Chairman of the Committee on Mound Exploration, made a partial report, as follows:

The committee have examined and made a survey of five groups of mounds. Two hundred specimens of pottery have been obtained, of which one hundred and twenty-six are quite perfect, the remaining specimens being in a fair condition, and may be wholly or in part restored. The collection also embraces the skulls of twenty individuals, of which number one is complete, seven nearly so, the remaining twelve being in fragments of sufficient size to be of value. They have also obtained the leg and arm bones, and in some cases the vertebræ and other small bones, representing twelve individuals.

On motion of Dr. Briggs, a further appropriation of $50 was placed at the disposal of the committee for the purpose of continuing the examination of mounds.

The Corresponding Secretary made his usual report.

Mr. Theodore P. Gillespie, a gentleman recently arrived from Peru, was introduced to the members by Dr. Briggs, and exhibited a beautiful collection of pottery taken from the burial grounds of an ancient tribe of Peruvians.

Dr. George Engelmann made the following report on the Meteorology of March, 1876:

The past March was not only an unusually cool month, but it made itself so much more disagreeably and injuriously felt, because it succeeded to a very mild winter, and an unusually early and favorable beginning of spring development.

The mean temperature of the past winter was 40.2°, and every winter month at least over 39°; February, the coolest, 39.3; and here comes March with 38.3, destroying the brightest prospects for full and early fruit crops. In the last forty-one years the mean temperature of March was over 5° higher than this year; six times it was lower than in the past month, but it never in that period of time was lower than that of each preceding winter month. As I have stated on a former occasion, the only winter equal to the past in mildness, was that of 1844–45, but the succeeding March was warmer (though not much) than any of the winter months, 6° warmer than our past March, and of course the early development of vegetation did not suffer destruction as it did in the last few weeks.

The quantity of rain (including snow, which, by the way, was unusually heavy), was also more than three inches above the average, viz., about $6\frac{3}{4}$ inches; but if we examine the records we find that in seven out of the previous forty years, the quantity equalled or exceeded that of last March; and eleven years ago (1865) it reached the enormous amount of 8.61 inches. All the seasons which followed such a wet March, exhibited a large and some of them an excessive quantity of rain.

MINING, METALLURGY, MINERALOGY.

The Problem of Mechanical Puddling attracted more attention during the past year than ever before, although the results obtained in the different manufacturing districts into which rotary puddlers have been most largely introduced are somewhat conflicting, from which it would appear that the problem of puddling by machinery has not yet been wholly solved. In certain quarters of England, and in Pittsburg, in this country, the Danks furnace has given great satisfaction, and the number of furnaces has been increased. In certain other districts the experience with this system has not been so fortunate, while the Crampton system has been very successfully operated.

In England, where comparatively greater activity in the manufacture of iron during the past year prevailed than in this country, the Crampton system, in this special field, appears to have been steadily gaining in favor. In our brief allusion to the Crampton plan in last year's *Record*, we noticed that its chief features resided in the adoption of a water-jacket arrangement and the use of dust fuel; and it is very suggestive to note that in certain modified Danks furnaces, lately erected in England, the leading improvement consisted likewise in the introduction of a water-jacket arrangement—approximating therefore in construction to the Crampton furnace in so far as the mode of coaling by water is concerned. So far as relates to the speed of working, both systems appear to be equally good, provided the apparatus is in good condition; but in the quality of endurance under the rough usage of practice, which in this case happens to be the test of commercial success, the friends of the Crampton system lay claim to decided superiority. With regard to the relative merits of the latter system and the modified Danks furnace just referred to, a competent authority speaks as follows: "As to what would be the relative endurance of two furnaces, each constructed on Mr. Crampton's plan, with water-jacket arrangements, but one worked on the Danks system and the other with dust fuel, there are no data for actually determining; but there are certainly no reasons for believing that the results would be in favor of the former." And the same authority sums up a comparative *resumé* of the subject in these words: "Altogether, when we consider the numerous advantages attendant on the use of fuel in the form of dust, and the general excellence of the mechanical arrangements which Mr. Crampton has designed and practically carried into effect for the utilization of such fuel, we can not but regard the Crampton furnace as the most advanced solution of the problem of mechanical puddling." On all hands, finally, it is admitted that the ultimate success of mechanical puddling is assured, and that the puddling process of the future will be carried on in rotary furnaces capable of dealing with large charges, and worked in connection with plant capable of easily manipulating the large puddled balls produced.—[*Harper's Annual Record*, 1875.]

Bessemer and Siemens-Martin Steel.—Perhaps the most reliable estimate of the relative values of the Bessemer and Siemens-Martin processes may be drawn from the following considerations, which embody substantially the opinions of eminent judges. There are at least two defects in the Bessemer process, or perhaps it would be better to say two obstacles to be encountered in the practical working of the method, that seem difficult to overcome. One is the great difficulty of directly using pig iron containing sulphur and phosphorus in any appreciable quantities, and the other, the difficulty of controlling the quality of the product. These obstacles are too well known to require enlargement. Though the first obstacle will not be so severely felt in the future in this country as in England, owing to the existence here of large deposits of ore in various localities, suitable for the manufacture of Bessemer pig, and which will doubtless be rapidly developed under the stimulus of an increasing demand; nevertheless, the cost of making pig suitable for this process is so much greater than the cost of ordinary pig, as to be a large item in a ton of rails. The difficulty of controlling the amount of carbon is also well known, and is a serious item in the cost. In every cast the amount of carbon must be determined, sometimes by chemical analysis, and again by tests of a mechanical nature.

The Siemens-Martin method has the advantage of the Bessemer in these particulars. Irons containing a much higher percentage of sulphur and phosphorus can be used, it being estimated that about two-thirds of the sulphur and three-fourths of the phosphorus are eliminated in the process. The crop-ends of bars, scraps, all descriptions of waste and old wrought iron can be utilized; in a word, grades of pig iron that could not be used in the Bessemer process, and much that would be waste, can be readily used. In the Siemens-Martin process the quality of the product is completely under

control. Should the metal at the time of testing be too soft, more pig can be added; while, if too hard, simply waiting a few moments will correct it. The loss in the open-hearth process is considerably less than in the converter; according to Gruner, about one-half. The great advantage of the Bessemer process lies in the large amount of steel that can be turned out with it, per day, and the cheaper cost of production. In some instances this amount has, with a pair of five-ton converters, exceeded 200 tons, while ten tons would be a good day's work with an ordinary open-hearth furnace. With the Pernot modification of the Siemens-Martin furnace, there is a prospect that this objection may be overcome. It is claimed that, with a Pernot furnace, forty tons of Siemens-Martin steel can be produced, and there is good authority for the statement that this claim is well founded. If this is true, then with six of these furnaces a product fully equal to that of a pair of five-ton Bessemer converters could be obtained. The cost of the plant would not be more than half that of a Bessemer, the quality of the product can be completely controlled, pig iron inferior to that demanded in Bessemer practice could be used, all scraps could be worked over, and the cost of steel, equal in grade to Bessemer, would not exceed the latter.—*W. H. W., in American Exchange and Review.*

The Soda Lakes of Wyoming.—An account of the soda lakes of the above-named territory is given herewith, upon the authority of Mr. Pontez, geologist of the Union Pacific Railroad Co. He describes, in a recent report, two such lakes, the larger one covering about 200 acres. The average depth of water in this lake is three feet, and its specific gravity is 1.097. The soda is nearly all carbonate. The second lake is situated near the first, and covers about 3½ acres. During the greater part of the year it is a concrete mass of carbonate of soda crystals. Mr. Pontez excavated to the depth of six feet without reaching the bottom of the deposit, which is constantly increasing from the influx from the larger lake. These lakes are situated about 65 miles from Rawlin's Station on the U. P. R. R. The quality of the carbonate is affirmed to be fully equal to that of the commercial article. Estimating the quantity by the specific gravity of the water, its depth and area, the large lake would yield in evaporation 78,000 tons, which, at current market price ($45 per ton), would realize $4,519,000. Besides the cost of freight, the expense of preparing the article for market would be $4 per ton for evaporating. The small lake, already crystallized, and estimated only at a depth of six feet, and an area of 155,000 square feet, contains 30,660 tons, which, estimated as above, would realize $1,379,700.—*Popular Science Monthly.*

Manganese Bronze.—Mr. P. M. Parsons, known in connection with the conversion of cast iron guns into rifled ordnance, as well as for the invention of "white brass," has brought out a new alloy, "manganese bronze." The addition of manganese to bronzes deoxidizes the latter. Its action is strikingly visible in the texture of the metal, the grain being fine and close, and the strength greatly increased. The new alloy may be forged at red heat, which increases its strength and toughness. Six specimens were tested: 1. A cast specimen of tough quality, adapted for constructive purposes, showed an ultimate strength of 24.3 tons per square inch, with an elastic limit of 14 tons, or an elongation of 8¾ per cent. 2. The same quality forged, had an ultimate resistance of 29 tons; elastic limit, 12 tons; elongation, 31.8 per cent. 3. A cast sample of harder quality broke under 22.1 tons per square inch; elastic limit, 14 tons; elongation, 5½ per cent. 4. The ultimate strength of this last quality, when forged, rose to 28.8 tons, the elastic limit was 13.2 tons, and the elongation 35.3 per cent. 5. A still harder sample. The cast test piece broke at 23.6 tons, with an elastic limit of 16.8 tons, and 3.8 per cent. elongation. 6. The same quality forged. Ultimate strength, 30.3 tons; elastic limit, 12 tons; elongation, 20.75 per cent. The first sample showed an ultimate strength equal to good wrought iron, while greatly superior to the best gun-metal, for which 16 tons and an elastic limit of 7 tons are high strengths. The effects of forging are striking, raising the strength to such high limits, and practically giving a new and most valuable metal to the world. In some respects, indeed, it resembles aluminium bronze, but is superior in resistance to this alloy, which does not exceed 22.6 tons, and is also inferior in elongation and elasticity. Manganese bronze will find an application wherever gun-metal is used, while the facility and benefit of forging will render it still more useful in construction.—*Condensed from "Engineering."*

Mineralogy.—The following paragraph of mineralogical novelties we condense from the *Quarterly Journal of Science:*

Dr. A. v. Lasaulx gives the name of *Siegburgite* to a new fossil resin found in the sands overlying the lignites of Siegburg, on the Rhine. It appears that its constitution is not uniform. The name of *Gastaldite*—in honor of Professor Gastaldé—has been bestowed upon a new mineral by Professor Strüner, of Turin. It is a silicate of alumina, soda, and protoxide of iron, crystallizing in the monoclinic system, and occurs in the copper ore deposits of the Val d'Aosta. The zeolitic mineral occurring at Neipigon Bay, on the north shore of Lake Superior, and described by Professor Foote under the name of *Zonochlorite*, has been analyzed by Mr. Hawes, and by him pronounced to be an impure variety of phrenite. It resembles the well-known chlorastrolite which is found in amygdaloid trap and in derived pebbles, on Isle Royale, Lake Superior. Mr. Hawes has also examined the chlorastrolite, and concludes that it is not a homogeneous body, and that a large proportion of the stone consists of impure chlorite.

Indianite is the name proposed by Professor E. T. Cox, the State Geologist of Indiana, to a pure white clay which forms an extensive deposit in Lawrence county, of that State. It resembles kaolin, and is in demand in the porcelain factories of Cincinnati.

Iron Furnace in California.—The Golden State is to have, near Clipper Gap, an iron furnace; the only one west of the Rocky Mountains, except one in Oregon. The cost per ton for pig iron is estimated as follows: Ore $3.00; limestone 25 cents; labor $3.75; charcoal $10.00 to $12.50; annual repairs for 5,000 tons $2,500, or 50 cents per ton; total $20.00. Transportation to San Francisco $3.66.

ENGINEERING—CIVIL, MECHANICAL, &c.

Monolithic Aqueduct.—The aqueduct from La Vanne to Paris, 135 miles long, is nearly entirely of *béton Coignet.* The Fontainebleau section of 37 miles, over dry quicksand, is composed of a series of arches, some of them 50 feet high. Eight or ten bridges of span from 75 to 90 feet, are also of *béton.* For foundation and gravel walls, the composition is, sand 2½, gravel 2½, hydraulic lime 1, Portland cement ¼. For pillars, abutments, &c., sand 4, hydraulic lime 1. The other portions, sand 4, hydraulic lime 1, Portland cement ¼ to ½.

Multiple Drilling Machine.—The Engineer shows a new multiple drilling machine, especially adapted for drilling plates in position, on straight or hog-backed girders. The drills may be adjusted at any distance apart, and to suit varying pitches of holes, and while they may be brought together within 3¾ inches, the driving-wheels, by passing each other upon different levels, may be nearly 6 inches in diameter. The feed is automatic or independent at will.

The Leard Road Steamer has two 4½ feet drivers, and one front driving-wheel in front 3½ feet in diameter. The drivers have an iron tire 7″ wide, and an iron rim 6″ wide and ⅜″ thick. The spokes are U-shaped, of spring steel, 1¼″ wide. The points are double-riveted to a steel hub, and the bend held to the rim with two rivets through rim and tire. The pilot-wheel is made in the same manner, except that the spokes are single. Over the central-hub and the spoke-ends is riveted a steel flange on either side, the two forming a bearing of 4½″ on the axle. The engines are double—one direct and one beam; are attached to the axle direct, with differential gear, allowing the two drivers to turn in opposite directions.

The rear of the engine is swung to the framework of the carriage from above, so as to allow it to swing and to work in whatever position the wagon may be. By taking out a single pin the engines may be detached and removed. The cylinders are 6″ diameter, 7⅝″ stroke; have rotary valves with independent cut-off, all controlled by one lever, which reverses and cuts off at any point. The engines make 3¾ revolutions to one of the driving-wheels. The boiler is of steel; the castings are cast-steel. The weight empty is only 4,800 lbs.; the nearest one ever built in weight and capacity being 7,500 lbs. It is designed to burn coke; makes no smoke and little noise. The steam is condensed and returned to the water-tank.

On a recent trial it ascended a grade of 1 in 6 with ease, and ran 15 miles an hour on a level road.

Steam Street Car Experiments.—The accompanying news items indicate that the subject of the substitution of the steam carriage for the horse car, is attracting wide-spread attention:

The trial trip of the "Woodbury Steam Car" was lately made under the auspices of the West Philadelphia Railway Company, and resulted quite successfully. The car, handsomely decorated, and having on board a large number of invited guests, left the depot at half-past 3 o'clock, and ran to Broad and Market streets, back to the depot, and thence to the Centennial grounds, creating a sensation in the throng of lookers-on who gathered along the route to see the "innovation." The car is 30 feet long by 8 feet wide, and is mounted on two four-wheeled trucks. The forward truck has a circular bed-plate, fitting neatly a corresponding curve in the forward end of the passenger department. On this bed-plate are the boiler, 30″ diameter, and the engines, vertical and downward acting, 7½″ diameter, 12″ stroke. The car weighs 22,000 pounds, and carries 40 to 100. So far as could be judged from one trip, and a rather casual inspection of the machinery, this engine and car seem to meet all the requirements of a steam street car. It has far more power and speed than necessary; it seemed to be entirely and easily manageable in starting and stopping within short space; it ascended steep grades with ease and descended them without danger; it turned the shortest curves with an easy, pleasant motion, and without the short jerky swings of the ordinary car; its fuel, being anthracite, made no smoke; there was no perceptible heat in the car from the boiler; the machinery itself was noiseless, and while a few horses pricked up their ears and became restive, not more than one in ten out of the hundreds of horses passed took any notice of the steam car whatever.

We may supplement the above with the following notice of the experimental trial in Leicester, England, of what is termed by the English journals "a novelty in Tram-car locomotion."

A public trial of a tram-car, which not only possesses the merit of being noiseless, but also of consuming its smoke and steam, took place on the line of tramways at Leicester, in the presence of a large number of scientific gentlemen who had been invited to the trial. This engine is intended for exhibition at the Philadelphia International Exhibition. The appearance of steam is prevented by the use of a patent condenser. The steam from the safety valve is also taken into the tank and condensed. The engine, which works independently of the tram-car, weighs about four tons and a-half, and is capable of running a distance of six miles without a further supply of cold water for condensation. It runs on four two feet steel wheels, and has the appearance of an ordinary tram-car (so as to diminish the chances of its frightening horses), the whole of the boilers and machinery being enclosed in a glass case. The engine is of 20 horse power, and while capable of running at the rate of twelve miles an hour, may be stopped while going at the rate of six miles an hour in the short space of 4½ yards. It ran up with ease a gradient of one in twenty, and the tram-car took the "points" at the junction or crossings with greater smoothness than with horses attached. The trial, which was in every way satisfactory, was witnessed by thousands of spectators, as the engine passed through one of the main thoroughfares of Leicester.

Chilling Car Wheels.—A new invention employs metallic annular chills, with annular air-chambers at those points of the interior surface of the chill where the outer flange and tread peripheries are formed. Thus the central portion of the tread is chilled and hardened; but the flange and outer thread periphery are left tough and strong.

Indestructible Train.—A Scotchman recommends passenger-carriages of strong vulcanized rubber. These would cost only about seventy-five cents per pound, and being necessarily about a foot thick, might afford very easy riding, unless made too elastic, when they would shake the passenger into a heap at slow speed, and bounce him about into a pulpy state when making fast time.

MISCELLANEOUS.

International Postage Stamps.—Now that the demand for an international postal treaty has been acceded to, and that for an international or universal *coinage* is seriously discussed, with prospect of an early solution of the problem, it may be *apropos* to suggest the filling of another, though less important, public want—that for an issue of postage stamps and cards which shall be current in all countries within the recent postal treaty. It so frequently happens that business, literary and scientific men wish to write to another country for some piece of information requiring that a stamp be enclosed for postage, and so frequently happens that they are debarred from obtaining the information desired from the inability to make the petty enclosure, that this is worthy of attention. A system of exchange at the post offices would prevent any complications arising from American postages being paid for in British stamps, or *vice versa.* Authors desiring *data*, societies, investigating committees, &c., would be much less hampered than at present, if these petty remittances could be made.

London Fires for 1875.—The number of calls was 1668. Of these, 90 were false alarms, 49 chimney alarms, 1529 calls for fires, of which 163 resulted in serious damage, and 1366 in slight damage. At 41 of these fires, lives were endangered, and at 26 of these, lives were lost. 109 persons were seriously endangered; 80 of these were saved, and 29 lost their lives. Of these last, 14 died in hospitals, 15 were suffocated or burned to death. There were 4050 chimney calls where no engines attended. Of these, 1248 were false alarms. The fire engines of the 48 stations made 6155 journeys, aggregating 18,710 miles. 10,502,605 gallons or about 47,000 tons of water were used; one-third of this was from river, canals and docks. There are 48 engine stations, 106 fire-escape stations, 4 floating stations, 54 telegraph lines, with 98 miles of wire, 3 floating steam fire engines, 1 iron barge to carry a land steamer, 5 large land steamers, 21 small land steamers, 14 seven-inch manual engines, 59 six-inch manuals, 12 small manuals, 132 fire-escapes, 395 firemen of all ranks. Cabinet-makers, booksellers, lodging-houses and stables furnished more fires than any other occupations. Candles furnished 163 causes out of 1529; defective flues, 63; escape of gas, 48; hot ashes, 50; spirit lamps upset, 65; lights thrown down, 108; sparks

from fires, 137. There were most fires on Thursdays (236 out of 1529); the 20th week of the year had the most (54), and May had the greatest of any month (180).

Barker's Hydraulic Brake.—From *Engineering* we glean that the Barker hydraulic brake is obtaining a more extended application, having found introduction upon some half dozen of the British railroads. The following is the record of two stops lately made with this brake in some trials recently made upon the Midland Railway, with a train consisting of ten carriages, each with the hydraulic brake, and a guard's van not so fitted, viz.:

	Gradient.	Speed of train in miles per hour, when brake was applied.	Time occupied in making stop.	Approximate distance run after application of the brake.
			Seconds.	Yards.
1	1 in 330 down	50	15	200
2	Level	50	18	200

Copying Pencil.—A thick paste is made of graphite, finely pulverized porcelain, and a concentrated solution of aniline violet blue, soluble in water. The paste then goes through the operation of being made into a pencil in the usual manner. These pencils make marks on paper which are capable of being copied, like those made with copying ink.—*Practical Magazine; from Les Mondes.*

Tropical Africa—Lieutenant Cameron, who lately arrived in Liverpool, has, in one journey, done, perhaps, more and better service to geographical science in Central Africa than any single explorer, with the exception of Livingstone. In one important respect, in the accuracy of his observations, he excels them all. After thoroughly surveying the Lake Tanganyika, Lieutenant Cameron started northwestward, and explored the head waters of the Congo, an immense river system, one of the feeders of which is the Lualaba, which drains Lake Tanganyika into the Congo, and which Livingstone erroneously believed to be a tributary of the Nile. Twelve hundred miles of this journey were over wholly undiscovered country, which is described as well watered, healthy and extremely fertile, capable of colonization by Europeans, and rich in gold, iron and copper. The extent to which the Congo and its tributaries are navigable is very important. They constitute, Lieutenant Cameron considers, one of the most magnificent systems of internal water communications in the world. As to the wealth of the newly explored country, he describes it as unspeakably great, adding the opinion that from its mineral resources and agricultural capabilities, it will become one of the granaries of the world, a centre of civilization and productive trade, and the scene of iron manufactures when other parts of the world have been exhausted. It is interesting that this tract of equatorial Africa, so long a blank on our maps, and believed to be an arid waste, or at all events a region of fen and swamp, should turn out to be one of the most inhabitable parts of the globe.—*Iron.*

A New Source of Caoutchouc has been discovered in Burmah, which, by cultivation, it is affirmed, can be made to yield an abundant supply. It is a climbing plant, of the family of *apocynaceae*, bearing the botanical name of *Chavannesia esculenta*, which abounds in the forests of that country, and which is cultivated for its fruit, the same possessing an agreeable acidity. Another plant of this country, the *Anodendron peniculatum*, likewise furnishes caoutchouc, but of inferior quality to the chavannesia. That afforded by the chavannesia is said to be very pure, and excellently adapted for commercial purposes.—*Le Technologiste.*

CHEMISTRY, TECHNOLOGY.

New Facts Concerning Litmus.—Wartha has detected the presence of indigo in commercial litmus, which is so largely used in the laboratory. He has found it in such quantity that he is disposed to regard it as an adulteration added for the purpose of imparting to the litmus cubes a deep blue color, and thus improving the appearance of the article. If a few particles of litmus are gently heated in a test-tube, the characteristic violet vapors and the dark blue sublimate of indigo at once appear. He likewise describes the following method for greatly increasing the sensibility of the litmus as a reagent, viz.: If some commercial litmus is placed in a good sized flask, and vigorously shaken with ordinary alcohol, there results a muddy, violet-blue liquid, which, when boiled, deposits indigo as a fine powder, while a fine red (or with some samples a green) fluorescing coloring matter, indifferent to acids, remains in solution. The litmus cubes that remain after this treatment, are covered with distilled water, and left standing twenty-four hours, the dark-colored liquid is poured off and evaporated to dryness on the water-bath. The coloring extract that remains is treated several times with absolute alcohol, containing some acetic acid, and evaporated to dryness again, so that the dry, brittle residuum may readily be powdered. This brown powder is now extracted with absolute alcohol and acetic acid, whereby great quantities of a scarlet coloring matter resembling orcëin will be removed. By this treatment, the remaining litmus will be found to be so sensitive, that it can be used for the titration of the carbonates of the alkaline earths in spring water, with the same accuracy as where cochineal is employed, which, with the ordinary litmus tincture, is found to be impossible. The brown residuum, according to Wartha, should be dissolved in water, filtered, evaporated to dryness on the water-bath and the remaining traces of acetic acid removed by moistening with absolute alcohol, and repeatedly evaporating.—*Berichte d. Deutschen Chem. Gesell.*

The Debasement of Silks by foreign admixture, if we may infer from the comments of journals devoted to textile interests, has of late reached such a height as to promise shortly to rival that of a class of cotton goods which have added largely to the notoriety, if not to the fame, of one of the manufacturing centres of England. A writer to one of the French journals shows that the weighting of black silks—which began with the modest aim of making up for the loss sustained in ungumming—is now carried to the extent of 100, 200 and 300 per cent. This increase of weight is effected by treatment with salts of iron and astringents, salts of tin and cyanides. The bulk is augmented proportionably to the weight. The same writer points out very clearly the evils attending this excessive adulteration. The chemical and physical properties of the silk thus treated are materially modified. What is sold as silk is, in reality, a mere agglomeration of heterogeneous matters devoid of cohesion, held together temporarily by a small portion of silk. The strength and elasticity of the fibre are likewise reduced. From being in its natural state one of the most stable of substances, and but slightly combustible, in its adulterated state it burns like tinder if touched by a flame. It is likewise affirmed to be liable to undergo spontaneous decomposition, and to absorb gases with the evolution of heat which sometimes leads to actual combustion. The adulterated silk when burning scarcely gives off the characteristic odor of animal matter.

Lenoir's Process of Silvering Mirrors, which has just been very favorably reported upon by a committee of the *Societé d'Encouragement*, is described as follows: He flows over the surface of the glass to be silvered, solutions of nitrate of silver and tartaric acid, by the interaction of which, a deposition of metallic silver is effected (Petitjean's method). In twenty minutes the deposition of silver commences, and within an hour it is complete. He then washes the silvered surface with distilled water, and sprinkles over it a dilute solution of the double cyanide of mercury and potassium, the effect of which is to liberate a portion of the silver, and to form with the balance a very white and strongly adherent amalgam of mercury and silver. The surplus liquid is then poured off, the surface is thoroughly washed, dried, and finally coated with varnish to protect it from destruction by friction.

Petroleum Oils.—Mr. Nystrom says that the temperature of distillation of any petroleum oil is

$$T = 1150\ S^3 - 215^\circ.$$

T = temperature of distillation (Fahr.).

S = specific gravity of the oil.

He also says that the temperature of inflammation of any distilled petroleum oil is

$$T = 1200\ S^6 - 140^\circ.$$

S = Specific gravity of the oil.

T = lowest temperature of the oil at which it will ignite by application of a lighted match.

Direct United States Cable.—Referring to the remarks in our last issue, it will be of interest to learn that the temporary break of this company's short cable, between Nova Scotia and New Hampshire, does not in any way affect the due transmission of messages between England and the United States and Canada. Until the necessary repairs are made, we learn from the *Telegraphic Journal*, messages are sent from Torbay, Nova Scotia, by the company's alternative route, *via* the lines of the Dominion of Canada and Western Union Telegraph Companies.

Methods of Estimating the Illuminating Power and Purity of Coal-gas.—The following is an abstract from a paper on above subject, lately read before the chemical section of the Society of Arts (London), by Prof. A. V. Harcourt:

The author, after introducing his paper, then passed on to the description of several compact forms of apparatus used in the laboratory for the estimation of sulphur in gas, and thence to the more important part of his subject—the illuminating powers of gas. After a few observations on the chemical constitution of coal-gas, the ingenious meter apparatus of Mr. Sugg was shown in action, its principle being the measurement of the volume of gas required to sustain a flame of standard dimensions for the space of one minute. The next mode of estimation of illuminating power brought under notice was the almost universally employed plan of comparing the power of the light from a standard burner with that of the familiar "standard candle." In both of these methods, however, the eye alone was necessarily used as a regulator. It was not until within the last year or two that more exact physical processes had been introduced—the first depending upon the application to photometric purposes of the substance selenium, the electric conductivity of which is very sensibly influenced by light. This fact had been originally observed by Mr. Willoughby Smith, and had been turned to practical account by Dr. Siemens and Prof. Adams. The other method was that devised by Mr. Crookes, on the completion of his brilliant discovery of the attraction and repulsion induced, by the radiation of light, in a small screen suspended in vacuo. The instrument in the form used was now already well known as "Crookes' Radiometer." When the various sources of error in connection with the use of the standard candle as the unit of photometry were considered, the advantages of the exact physical estimation must be at once admitted. It would, however, even in the event of the abolition of the actual use of the candle, be in all probability well to retain the verbal term which might be made to express a definite and invariable value. He (the author) had himself found much convenience in the application of a standard gas, readily manufactured from hydrogen and petroleum in the laboratory.—*Iron.*

Electric Lighting.—Experiments in electric lighting have been continued at the Northern Railway Station, Paris. We hear that the Northern Railway Company will, if these trials are satisfactory, light the arrival depot by electricity. This building encloses a space of 300,000 cubic metres. For this purpose four electric lights will be used, rather more powerful than the one used in the luggage rooms and the custom house, which is employed from 5 o'clock till midnight. At the trials of which we speak, a Gramme machine was being tested, giving a light equal to 100 jets of gas, consuming 150 litres an hour. At the factory of MM. Sautier and Lemmonier, experiments have lately been made with the photometer and dynamometer, the results of which show that this powerful machine gives a light equal to 1,850 Carcel burners. The equivalent consumption of oil would be 71 kilogrammes an hour; of gas 194 cubic metres (equivalent to 650 kilogrammes of coal). The cost of the electric light is about one-hundredth part that of oil.—*Moniteur Industriel Belge.*

Underground and Overground Telegraphs.—It is worthy of remark that while in this country we are just in the midst of a discussion upon the feasibility of doing away with the objectionable system of carrying lines of telegraph on poles through the crowded streets of our cities, and the substitution therefor of subterranean lines, the latter system has been in successful operation in the cities of Continental Europe and in England, for the past twenty-five years. In many instances, indeed, on the continent, there are long lines of underground telegraph extending through the country, notably the lines connecting the German fortresses; and the cable laid directly in the surface of the ground is in several instances adopted for crossing the Alps and other mountainous districts. The report has just appeared that a subterranean line will be laid down at once between Halle and Berlin, and that in future *all* German telegraphs will be underground. The advantages of the underground or cable system, as contrasted with the aërial system, are obvious. It obviates, to a large degree, the numerous causes of interruption of communication resulting from the breaking of wires by accident or malice, accumulations of sleet, ice, &c., the frequent falling of poles, and the general imperfection of insulation so severely felt by operators during a long spell of wet weather, to say nothing of the disfigurement of the highways by posts and wires, which no amount of ingenuity can make sightly or attractive. That the unsightly pole system, with its many objectionable features, which have long ago secured its banishment from the cities of Europe, should still be suffered to exist in the cities of this country, which, of all others, has done more than any other to develop and improve the art of telegraphy through a host of ingenious inventors, passes all comprehension, and affords conspicuous example of indifference in the adoption of a demonstrated improvement, and to the rights of communities, which is eminently un-American.

Crystalline Surface for Wood, Paper, etc.—Prof. Böttger recommends the following as the simplest method of giving paper and wood surfaces a crystalline coating: Mix a very concentrated cold solution of salt with dextrine, and lay the thinnest possible coating of the fluid on the surface to be covered, by means of a broad, soft brush. After drying, the surface has a beautiful, bright mother-of-pearl coating, which, in consequence of the dextrine, adheres firmly to paper and wood. The coating may be made adhesive to glass by doing it over with an alcoholic shellac solution. The following salts are mentioned as adapted to produce the most beautiful crystalline coating, viz.: sulphate of magnesia, acetate of soda, and sulphate of tin. Paper must first be sized, otherwise it will absorb the liquid and prevent the formation of crystals. Colored glass thus prepared, gives a good effect by transmitted light.—*Bäyer. Indust. u. Gewerbe-Blatt through Practical Magazine.*

[Visiting cards prepared by the use of sugar of lead were at one time much in vogue; the above recipes, being non-poisonous, are greatly to be preferred.—Ed.]

Tungstate of Zinc as a White Paint.—If to a solution of tungstate of soda there be added a solution of a zinc salt, a snow-white tungstate of the oxide of zinc is at once precipitated, which covers well, and is especially to be recommended for fine painting. As an oil color it is affirmed to be superior to every other white coloring matter.—*Polytech. Notizblatt.*

Experiments in Fire Protection.—A series of conclusive experiments have lately been made at Vienna, to determine the best means of preventing fires. These experiments were made with ordinary textile fabrics, with goods, likewise, of great fineness of texture, and finally, with woods employed for constructive uses. They were made with mixtures of certain salts, proposed by M. Patera, which have the property of checking the combustibility of woven tissues, and of opposing the propagation of the flames. The experiments were conducted with

1st. A mixture of *borax* and *sulphate of magnesia.*

To prepare this recipe, 3 parts of borax and 2.25 parts of the sulphate of magnesia, are dissolved in 20 parts, by weight, of water. The action of this mixture depends upon the formation of a borate of magnesia insoluble in hot and cold water, which envelopes and impregnates the threads of the tissues, or the fibres of the wood, and hinders the development of combustible gases and the propagation of flame.

2d. A mixture af the *sulphate of ammonia* and *sulphate of lime* (or gypsum) in different proportions, according as it is proposed to employ the same on materials more or less fine in texture. The result of this mixture, as in the foregoing case, is the formation of a double salt, which does not manifest—save perhaps to a slight degree—any of the disagreeable properties of the ammonia salts. The action of this mixture of salts, which, by reason of their cheapness, is susceptible of numerous and extended applications, depends, likewise, on the incrustation and impregnation of the fibres; in virtue of which it not only opposes the propagation of flame, but also by the liberation of ammonia at an elevated temperature, smothers the flame.

A mixture prepared by adding 33.3 parts of *liquor ammoniae* to 66.6 parts of sulphate of lime, and applied in concentrated form as a coating, will be found to be a cheap, convenient and effectual agent for the protection of wood-work of every description. The wood is not made absolutely incombustible, but it kindles only with the greatest difficulty on contact with a burning body, and ceases to burn at once on the removal of the cause of its ignition.

A shingle roof, which had been thoroughly cleansed by a rain, and which was in condition to take fire very easily, was impregnated with the above mixture; upon this was spread a layer of pitch and drying oil, which greatly augmented the liability to take fire; nevertheless, we are assured, the experiment of firing it was not successful. The experiments on the large scale, with wooden huts protected in the manner above detailed, are affirmed to have proved so successful, that the Austrian Minister of Finance has recommended the adoption of this method of protection in the public buildings of the Empire.—*Oesterr. Zeitschrift für Berg-u-Hütten-Wesen.*

BIBLIOGRAPHICAL NOTICES.

PRACTICAL INSTRUCTION IN THE ART OF WOOD ENGRAVING, for persons wishing to learn the Art without an Instructor. Containing a description of tools and apparatus used, and explaining the manner of engraving various classes of work. Also, a History of the Art, from its Origin to the Present Time. By William A. Emerson. Illustrated. 52 pp., 16 mo. Published by Charles J. Batchelor, East Douglass, Mass. 1876. Price 50 cents.

The matter is interesting and well arranged, but the illustrations, typography and presswork are poorly executed. The work is an illustration of the principle that a man may teach a horse how to canter, without being able to canter himself.

WATER WHEELS; OR, HYDRAULIC MOTORS. Translated from the "Cours de Mécanique Appliquée," par M. Bresse, Professeur de Mécanique à l'Ecole des Ponts et Chaussées. By F. A. Mahan, Lieut. U. S. Corps of Engineers. Revised by D. H. Mahan, LL. D., Professor of Civil Engineering, &c., U. S. Military Academy. New edition, with the French measures translated into English. 165 pp., 8 vo. New York: John Wiley & Sons, 15 Astor Place. 1876.

This new and revised edition of a valuable standard work, gives very clearly and thoroughly the theory of operation of hydraulic motors. The formulæ are simply expressed; and the use of the English measures will enable unprogressive engineers to use the work with ease. Just why, in the revision, the *metric* quantities were omitted, we are unable to see, and we hope that the next edition of this valuable work will use *both* notations.

THE TEXTILE COLORIST, a monthly journal of Bleaching, Printing, Dyeing, and Finishing Textile Fabrics, and the manufacture and application of coloring matters. Edited by Charles O'Neill, F. C. S.

The February number of this valuable special magazine contains articles on the Dip Blue styles of Calico Prints (with one diagram and seven samples of calico prepared by the recipes given), Japan Wax in size, Electrolytic Aniline Black, Improvements in Steaming, fifty collected recipes for blacks for printing, &c., besides two series of digests of patents, and a thirty-two page supplement on Bleaching. $12 per year. John Wiley & Sons, New York, are the publishers in this country.

NARROW GAUGE RAILWAYS IN AMERICA. A sketch of their Rise, Progress and Success. Valuable statistics as to Grades, Curves, Weight of Rail, Locomotives, Cars, &c. Also a Directory of Narrow Gauge Railways in North America. By Howard Fleming. 104 pp. Illustrated. Second edition, 1876. To be had of the author, at 311½ Walnut street, Philadelphia.

This valuable and timely little work treats very ably of a special railway interest which is growing very rapidly. The new chapter on construction, containing formulæ for earthworks, and for laying out curves, should prove useful and acceptable to engineers. "To railroad companies, the corporate history and reports of organizations other than their own may induce comparison, and it is hoped that their relation to each other may be drawn closer by the construction of connecting roads. To the public, whose desire for cheap means of transportation to open up rich mineral and agricultural sections, so that their latest products may be converted into wealth, and who desire to attain that end with the smallest outlay, this *brochure* is offered for reflection."

The statistics of progress, &c., are complete up to February, 1876. They show 7,973 miles projected in North America since 1870; of which there have been completed in the five years following, respectively, 179, 450, 555¼, 818¾, and 585 miles, being a total of 2,687 miles completed.

The work, although small, is well worth a table of contents or an index. It deserves, and will doubtless attain, a wide circulation. We hope to have space to make extracts from it.

"AURORA BRAZILEIRA. Engenharia, Mechanica, Sciencia, Agricultura, Artes e Manufacturas."

The March number of this handsomely printed and illustrated monthly, contains interesting articles on Steam Pumps, Hydraulic Rams, Man and Nature, the Tunnel from France to England, Fish Joints, the Works at the Mouth of the Mississippi, Fertilizers, the Devastation of Forests, Brick Machines, the Manufacture of plaster of Paris, Paper Folding Machines, Centennial Notes, &c.

This is the only paper published in the Portuguese language, intended for circulation in Brazil, and devoted to Engineering, Mechanics, Arts, Science, Agriculture and Manufactures. The terms are ten thousand *reis* per annum; which, being interpreted, means $5. Edited and published by J. C. Alves Lima, Syracuse, N. Y.

The following have likewise been received; but the press upon our columns this month has been so great, despite our increase in size, as to crowd out several reviews which are held over for our next, viz.:

Bulletin of the United States Geological and Geographical Survey of the Territories. Vol. II, No. 1. Washington: Government Printing Office, March 21, 1876.

Quarterly Report of the Chief of the Bureau of Statistics, showing the Imports and Exports of the United States, and other Statistics relative to the Trade and Industry of the country for the three months ending December 31, 1875, and also for the corresponding quarter of the year immediately preceding. Washington: Government Printing Office. 1876.

Geological Survey of Alabama. Report of Progress for 1875. By Eugene A. Smith, Ph. D., State Geologist, Montgomery, Alabama. 1876.

Report of the Condition of the Academy of Natural Sciences of Philadelphia, on moving into its new edifice, S. W. corner Race and Nineteenth streets. Made to the contributors to its Building Fund, April 28, 1876. By W. S. W. Ruschenberger. Philadelphia. 1876.

Annual Report of the Secretary of Internal Affairs of the Commonwealth of Pennsylvania for 1874–5. Part III. Industrial Statistics, Vol. III. Harrisburg. 1876.

Iron Works of the United States. A Directory of the Furnaces, Rolling Mills, Steel Works, Forges and Bloomaries in every State. Prepared by the American Iron and Steel Association, No. 265 South Fourth street, Philadelphia. Centennial Edition. Philadelphia. 1876.

EDITORIAL CORRESPONDENCE.

ON THE LEGAL HORSE POWER OF STEAM-BOILERS.

To the Editors of the POLYTECHNIC REVIEW:

There appears to be some doubt about the legality of my formula for horse power of steam-boilers, and the *Scientific American* says that "it is certainly not legalized." The unit *horse-power*, namely, 33,000 *minute foot-pounds*, which is the same as 550 *second foot-pounds*, differing only slightly in different countries to accommodate the different units of weight and measure, was established by James Watt, and has since been legalized in all parts of the civilized world. This unit of horse power is acknowledged in any court of justice, and it is upon this unit that my formula is based. Therefore, my formula for horse-power of steam-boilers is legal wherever Watts' rule is legalized.

Watts' horse-power can be expressed by a great variety of formulæ, and in this case it is transformed into power of evaporation; and thus the *Scientific American* could not recognize it to be the same as Watt's rule, but compared it with measuring cloth and calico with different lengths of yard-sticks!

JOHN W. NYSTROM.

CENTENNIAL NOTES.

[Those exhibits marked with an asterisk (*) will be described more particularly and in detail, in our next number.]

Stillwell & Bierce Manufacturing Co., Dayton, Ohio, have several of Stillwell's patent lime-extracting heater and filter, and the "Eclipse" turbine.*

The Morse Twist Drill and Machine Co. exhibits a beautifully arranged case of "Increment Twist" drills, of fine finish, and ranging in size from $\frac{1}{32}$ to 2½ inches in diameter.

Poole & Hunt, Baltimore, Md., have a 32½" Leffel turbine, set in a cast iron flume and penstock; a fertilizer-mixer; some mill-gearing with adjustable wooden spur-teeth; a feed-water pump and heater, &c.*

The Pennsylvania Diamond Drill Co., of Pottsville, have two drills, and also show a number of fine specimens of drill-cores. One of these, about 7" in diameter, and taken from a 9" bore, is 10 feet 9 inches long, and was taken from a depth of 200 feet, the entire depth of the hole being 357 feet.*

Wincester Rock Drill Co., of Springfield, Mass. (space 6619), exhibit not ready to be described.

W. Cramp & Sons, Philadelphia, small double vertical marine engine.*

John W. Griffiths, of N. Y., exhibits (section B-10, column B-74) a universal wood-bending machine, capable of bending timbers 5×6 inches, for wooden vessels up to 400 tons capacity; also large ship's knees bent by larger machines, etc.*

The Strange Cylinder Saw Co., Taunton, Mass., show a cylinder saw, and amateurs' scroll and circular saws.*

Exhibit 5573 is Weston's friction clutch, on a 6 feet wheel. In this, lateral friction between alternating annular plates of iron and wood (one set connected with the shaft, and the other with the periphery of the driver wheel) transmits the power. This exhibit is worthy of special note.*

Reallier, of Brussels, shows four Le Tellier purifying filters; and one "Hydrotimetric" filter, by W. Van Goethem.

Moreau, of Brussels, shows the Greinde rotary pumps—the revolvers being unequal in diameter.

Lidgerwood Manufacturing Co., N. Y., show hoisting machinery.

Fitts' road steamer "Americus," is at the west end of the Machinery Hall.*

Mr. George B. Grant exhibits two calculating machines; one, a desk apparatus on the Colmar system, the other, quite a large machine.*

MM. Nikaise & Gobert, of La Louviere, Belgium, have a large double punching-press, and one single; a nail-machine, and a gang-drill for four bits.*

The immense shears in the Belgian space, support coal-cutting and hoisting apparatus, by Valère Mabille, Mariemont. The ponderous vertical wrought iron beam, with cross-head bearing three rows of sharp cutters, finds work for the immense chaldron or hoisting-cage which hangs next it, while the huge grappling-tongs at the other end of the cross-beam serves to remove rocks, &c., up to six feet in diameter.* The same firm shows a number of locomotive buffers with disk heads and volute springs, and has also a section of an iron telescopic shaft caisson and head.*

Green & Co., Wakefield, England, have a vertical tubulous boiler with patent scrapers and gearing, the scraper traversing the vertical tubes, which they surround.*

Wm. Baird & Co., Gartsherrie, exhibit a horizontal coal-cutting machine on a track. There are two horizontal steam cylinders, at an angle of 120°, and driving a sprocket-wheel. Driven by this, and kept extended by an adjustable arm bearing on another sprocket-wheel, is a chain carrying cutting bits. An automatic crab feeds the machine ahead at the desired rate.*

Thorne, DeHaven & Co., Philadelphia, have a gang-drill for six bits, and seven radial and adjustable drills.

The American Saw Co., Trenton, N. J., has an Ivens & Brooke twin eccentric-geared cutting and punching press.*

Hilles & Jones, Wilmington, Del., have three radial drills, and a slotting machine.

H. W. & R. Lafferty, Gloucester, N. J., a battery of four centrifugal machines.

W. F. Murphy's Sons, Phila., Hickok's ruling machines.

Howell & Brothers, Philadelphia, exhibit a 24" wall-paper printing machine for 12 colors, made by J. & E. Waldron, of New Brunswick, and a drying frame and belts for the printed paper as made.*

Julius Blancke, Merseburg, case of steam, water and vacuum gauges, levels, counters, etc.

C. Schlickeysen, Berlin, brickmaking machinery.*

In the Brazil an space there is a marine engine made at the navy yard shops in Rio de Janeiro.

W. S. Symonds & Co., Halifax, N. S., show a quartz-crushing machine, with four stamps.

R. Mitchell & Co., Montreal, show a machine for making seamless lead pipes and bends.*

["*Centennial Notes*" *continued in* "*Industrial Department.*"]

INDUSTRIAL AND BUSINESS DEPARTMENT.

The Publishers, having seriously felt the need of a Department in their REVIEW in which Manufacturers, Inventors and others might have the opportunity of presenting and advocating special business interests, have decided upon opening an *Industrial and Business Department* in which those above named may present their specialties in detail, and with that particular reference to business interests which the Publishers must necessarily exclude from the body of the REVIEW.

THE POTTIN BILLIARD TABLE.

Very prominent among those refining influences which are at once the sources and effects of civilization, stand games, song and the dance; and those nations stand pre-eminent in such advancement which are the most fertile in conceiving, and the most accurate in practising games of skill and calculation. Dice and their hazards please and interest the degraded, the ignorant and the vicious, in a marked degree, while they may afford the refined a momentary relaxation. Cards, calling for keen observation, shrewd foresight and well-weighed judgment to aid or frustrate a fickle fortune, stand higher in the scale, and prove sources, by turns, of languid pleasure, fierce excitement or bracing mental exercise. Backgammon brings dice to the level of cards as a source of enjoyment combining skill and chance. "Checkers," as the game of draughts is now called, school the mind to foresight, promptness and judgment, and pave the way for Chess, the king of mental games. Here, on the level plain, meet in battle array the fierce knight and the stubborn pawn, the crafty bishop and the elephant-borne castle, protecting and attacking thrones and royal powers. In chess, calm deliberations, cautious watchfulness, careful ward and rapid onset school and skill the brain. But there are times when the brain wearies of problems, and the body calls for action; and here the game of Billiards, with its demand for keen eye and careful hand, affords a recreation unexcelled. Where earlier kings turned to tennis and the racket, modern princes poise the cue and send the ivory spheres on their intricate but unerring missions, and the whole system finds, as desired, exercise or relaxation.

The game of billiards is so popular, even under the many difficulties ordinarily attending its practice, that it might prove interesting to learn its source and development; but, like St. Patrick's birthplace, many countries claim it. From one authority we learn that the Crusaders introduced it into Europe, and that it soon became a favorite amusement among the monks and monasteries. Louis XI, of France, is said to have brought it to his court, and Henry III proved a patron who introduced it more widely and among the higher classes in France, after which it became known in England. But Henri Devigne assigns its invention or introduction to an artist of the time of Charles IX, while the *Dictionnaire Universel* and the *Académie des Jeux* ascribe it to the English. Bouillet, in the first of these works, says that the game, like the name, was derived from Bowls, and was brought into France by Louis XIV, whose physician recommended it. Strutt thinks that it is the ancient game of *paille-maille*, but played upon a table, thus saving the stooping or kneeling required in the older game.

It certainly was common in Shakspeare's time, and he makes Cleopatra, in the absence of her beloved Antony, say to her attendant:

"Let us to billiards:
Come, Charmian."
(Ant. and Cleo., act ii, scene 5.)

The game was originally played by driving a ball through a ring revolving on a pin or stick. Cotton's "Complete Gamester," 1674, speaks of this "most gentile, cleanly and virgine game," and assigns its origin to Italy, although elsewhere he credits Spain with its inception! Strange as it may appear, Hoyle omitted all mention of it, and only in the later editions of his work does notice of the game appear.

The name, as we have it, is derived from the French "*billard*," the stick once used to propel the ball, and which succeeded the *mace* first used, only to give place to the cue as now known.

Unfortunately, this very popular indoor game has been heretofore hindered in its extension by the great size, cost, weight and uselessness for other purposes of the table needed to play it upon. These drawbacks have prevented it from becoming a *household* game, except where a special room and table may be provided at great first cost and expense, and inconvenience of maintenance. The wealthy may have billiard rooms and tables, but the members of the great middle class, who outnumber them an hundred to one, can avail themselves of the attractions of billiards only under circumstances often demoralizing in their influence.

Public resorts, such as hotels and saloons, &c., fairly *coin* money by providing tables for the nimble players who pay for these tables several times over in the course of a year; and the receipts of the bar generally connected with the billiard room, still more largely augment the profits, and have cast unmerited discredit upon the game from its ordinary associations.

Mr. Henry Pottin, an ingenious inventor, well known for his fertile resource and quick appreciation of healthful popular demands, conceived the idea of rendering billiards possible as a healthful *household* recreation for the million.

Reflecting that in most American families the dining-table is used only at meals, and during the rest of the day occupies space without any compensation therefor, Mr. Pottin conceived the idea of combining a billiard table with the festive board, so that, after the walnuts and the wine of a formal dinner, or the roast beef and pudding of a more homelike meal, billiards might follow in due course, and "under one's own vine and fig tree."

In Mr. Pottin's Dining Billiard Table (shown in Figs. 1, 2, 3), a dining table, of the full size for playing billiards properly, has a double bed, one fixed upon six stable and handsome legs, and the other capable of being raised from a height of 31″ to that of 57″, by means of pinions and racks passing through the end-legs. The end-pieces may be removed from the table as arranged for dining. The removal of these end-pieces exposes the end of the crank-shaft, which passes longitudinally under the lower bed of the table, and, by means of two spur-wheels, actuates two vertical racks passing through the centre of the end-legs, and which elevate the upper bed to a height of 57″, when it is reversed, and then brought to a height of 34″. The border pieces are quickly folded up into position, and the table is ready for the clicking of the balls. To transform the table back again to the family board, the side pieces are folded down, the bed lowered, and the cases slid on the ends, when the snowy linen may be spread and garnished for the family meal.

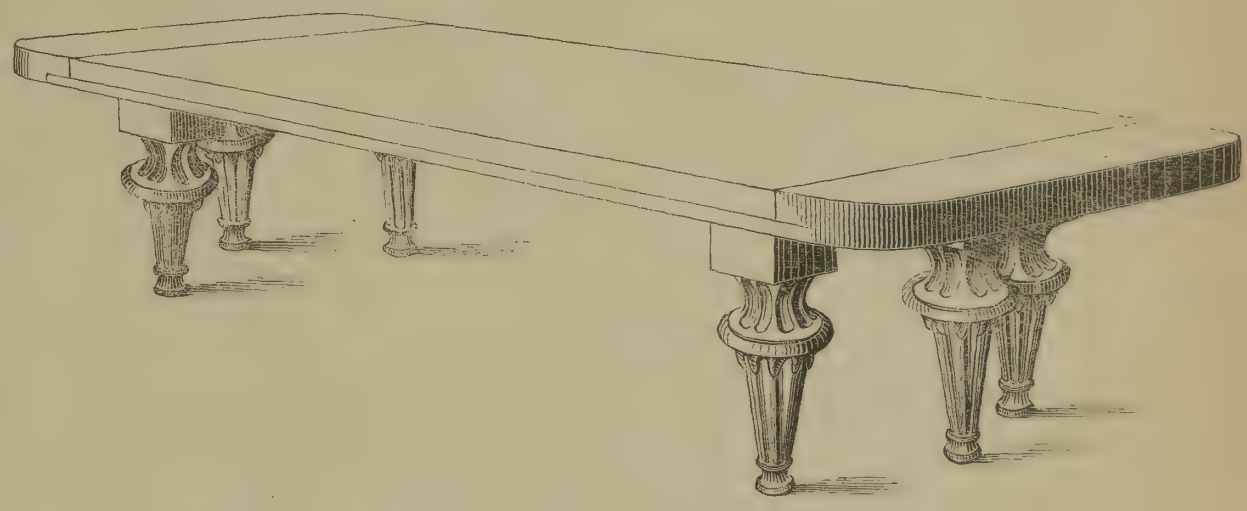


Fig. 1.

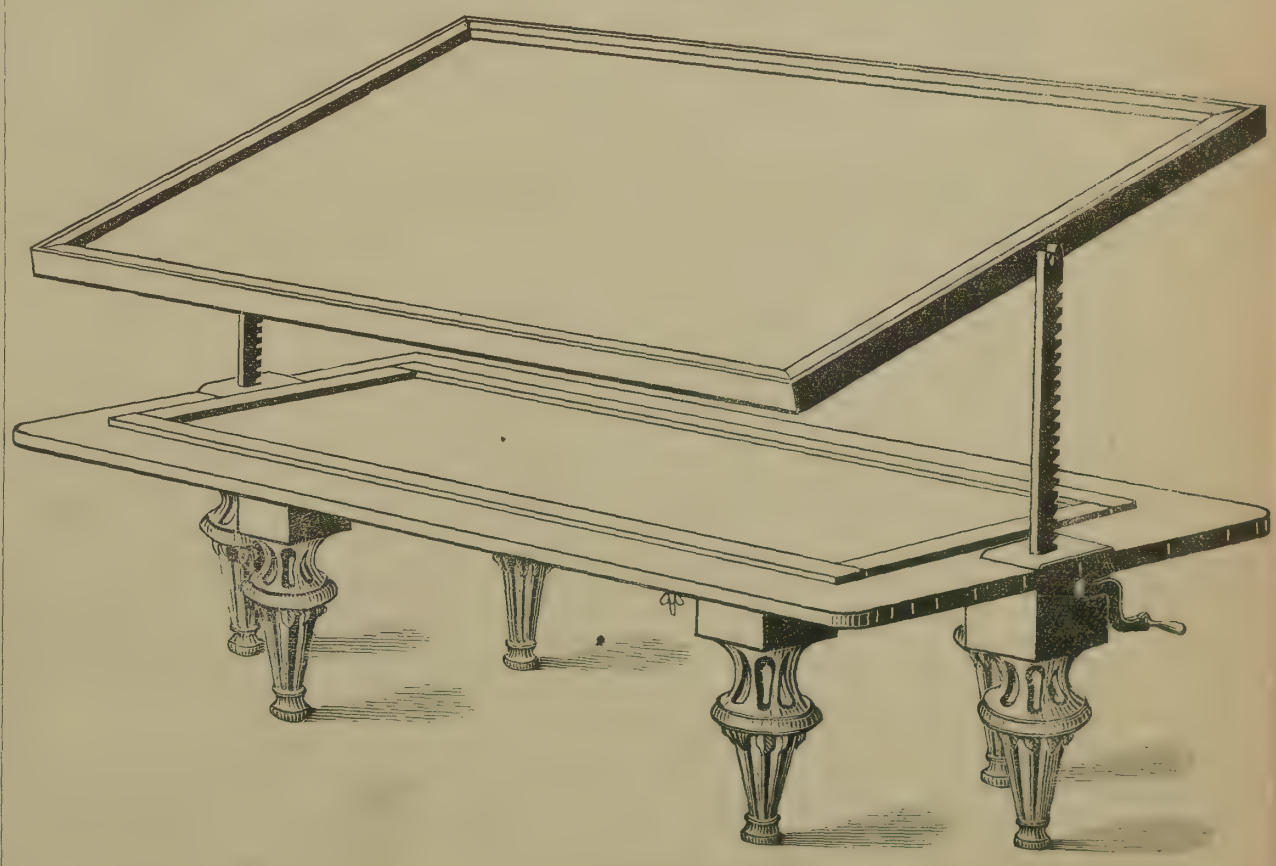


Fig. 2.

The requisites for a billiard table are a height of thirty-four inches, perfect stability, and a level plane with square and even border to support and protect the cushions. But an ordinary dining table, even though firm and stable, is but thirty-one inches high, and is devoid of border or cushion.

Young men need not frequent the gay saloons blazing with gas, gaudy with coloring and glittering with mirrors, but may enjoy the game under purer auspices and with greater convenience. The conve-

nience and influence for good, of one of these tables, cannot be over-estimated. But Mr. Pottin, in his desire to popularize home amusements, has gone still farther and provides, in his Parlor Billiard Table (shown herewith, Figs. 4, 5, 6), a very convenient means of playing all the home games mentioned in the beginning of this article, and each of which requires a special board or table, and also gives all

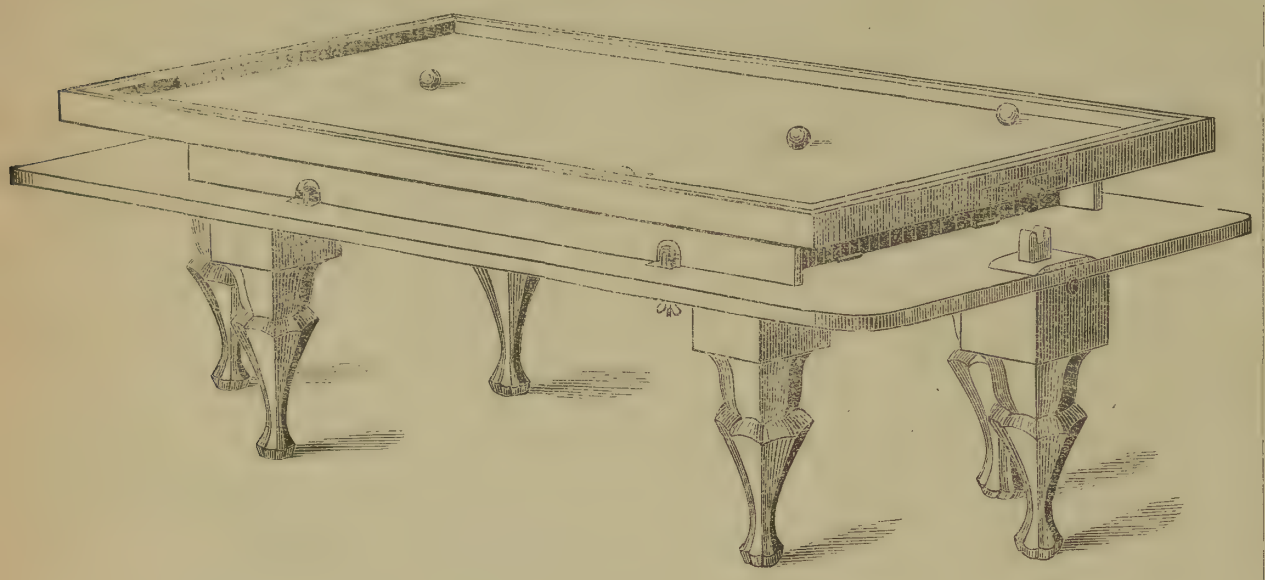


Fig. 3.

the facilities for the game of billiards, without the necessity of the larger table, which the young men affect.

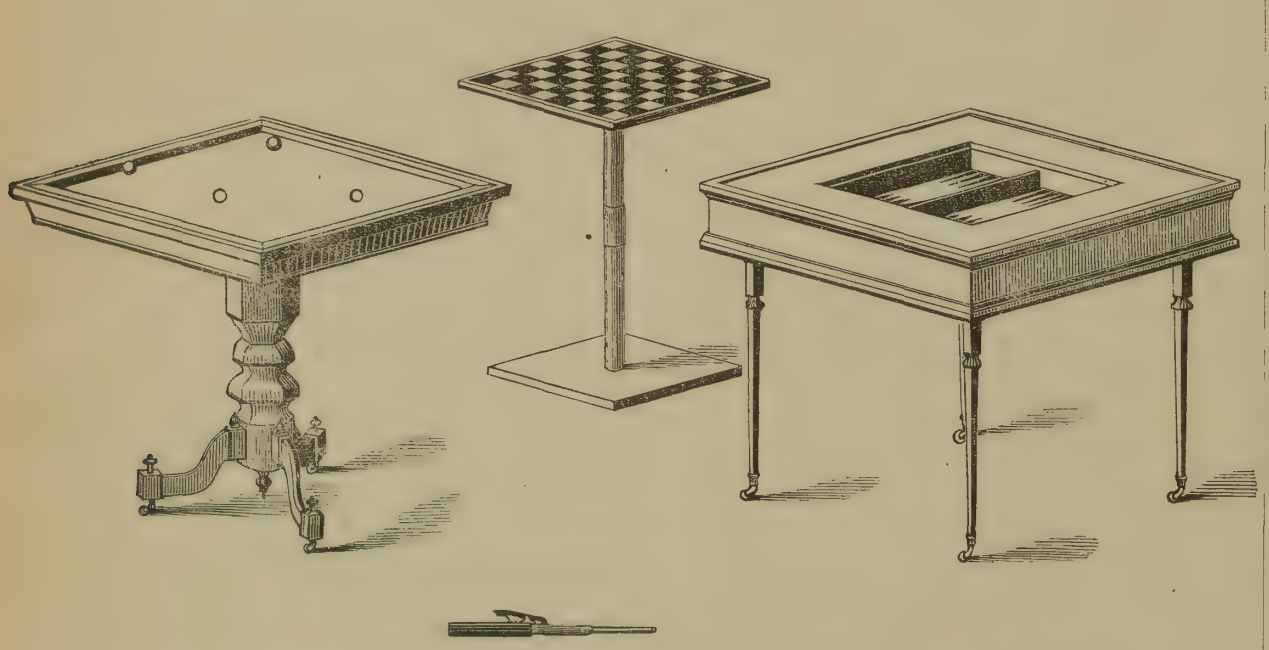
For the daughters and children of the household, Mr. Pottin has designed his Parlor Billiard Table—which, in the small compass of an ordinary substantial and handsome centre table, provides a square billiard table (34×34 inches) on castors, and with leveling

green cloth on the other for a game of cards. This square piece is laid upon the 18 inch square table above described.

It is therefore clear that, by means of this invention, there are furnished three games which can be played together or separately at will, the whole three united forming a remarkably handsome parlor centre table of the most fashionable style, upon which books, flowers and the usual ornaments of a centre table can be displayed.

Each table, both parlor and dining, is provided with a Pottin Electric Register, to tally the game.

The table would well deserve the name Protean, were it not for the fact that while, like Proteus, it can assume any one of a number of forms at will, the possessor of a Pottin Parlor Billiard Table may have



Figs. 4, 5, 6, 7.

screws. The cues are handsome pieces, 20 inches long, with internal spriral springs, which propel the balls in their intricate and mazy though unerring passage. By this cue all the effects of an ordinary cue are obtained, and all the difficult shots of a large billiard table are accomplished with great ease. The game is played in a sitting position, and each stroke is recorded by a push-button and bell.

The cover of the parlor centre table has concealed within itself folding legs, by means of which it can, when removed from the billiard, at a moment's notice, be converted into an independent table. This is the backgammon table, the backgammon being displayed in the form of a depression or cavity in said table, 20″ square by 3″ deep. When in the condition simply of parlor centre table this cavity is filled up by two boards, 13 inches square by one inch in thickness, and two sticks with screw joints, which, when united end to end, form a single one. Each end of this single stick is again screwed into the centre of the 18 inch square pieces above mentioned, forming a third complete table, upon which the game of chess or cards can be played. This cover of the depression in the parlor table, is 21×21 inches, which is marked with a game of chess on one side and covered with

at will any or *all*, simultaneously, of the tables which it forms.

Thus, under the parlor lamp, the united household may find employment for the most dissimilar tastes, while the convenience and compactness of the device leave nothing to be desired.

These inventions are manufactured by the Pottin Parlor Billiard Table Manufacturing Co. (of which Mr. Henry Pottin is President), at No. 727 Chestnut Street, Philadelphia.

OLD LITHOGEN.

The natural building stones—the granites, sandstones, limestones, etc., although eminently adapted for the production of structures of permanence, are by no means so abundantly or universally distributed as to be always available as materials for construction. The varied requirements and conditions of civilization have made the question of cost an important one, in this as in most other problems, and since the materials afforded by nature are often too difficult to obtain, or too costly, the necessity of producing artificial substitutes for the natural building stones was very early manifested, and has given origin from time to time to a host of processes for the manufacture of artificial materials for constructive purposes.

In the brief space at disposal, it is impossible to do more than bring into the prominence it deserves one of the most important classes of these artificial building materials, namely, the so-called *cements* or *hydraulic mortars*. The peculiarity of the hydraulic mortars resides in the fact that, under the influence of water, they become hard and quite insoluble, and are thus enabled to successfully resist the destructive influence of this element. Hence, this mortar is one of the most essential requisites for all hydraulic constructions, as it would be impossible to erect a durable structure under water without having recourse to it, unless the use of mortar be abstained from altogether and large and carefully prepared blocks of building stone used instead. The enormous cost and the difficulties of the latter method would undoubtedly reduce the number of such constructions to a minimum, and, to employ the fine expressions of Michaëlis, "where we now see imposing lighthouses boldly defying the threatening pressure of the waves, the mariner might be exposed to all the dangers of the coast without a warning signal, or a guiding beacon; where splendid ports, with massive docks and bulwarks, effectually protect trade and commerce against the indomitable nature of a powerful element, we would probably find no trace of the lively intercourse that animates our principal seaports, had not human skill and ingenuity found means to replace by art what nature has either refused, or granted only to a few favored localities." Nor is the usefulness of the hydraulic mortars restricted to the erection of subaqueous structures; on the contrary, it is made in innumerable situations to replace air-mortars, and in most instances where the latter is employed the former may be substituted for it with great advantage. These remarks are intended to apply to the best descriptions of hydraulic mortar—to what is known as "Portland Cement." The extraordinary hardness which these cements acquire in a short time, has caused their introduction and employment under the most varied circumstances. Mixed with sand, or with gravel and fragments of stone, there is scarcely any situation where a material for construction is required in which they may not be applied with advantage. Mixed simply with sand, the hydraulic mortar affords a vastly superior cement to the ordinary lime mortar, and as concrete and beton its applications are legion. For roadways and footways it cannot be excelled, even by the best natural stone, and for masonry work of every deecription, its value cannot be over-estimated. It affords the great advantage that it enables the constructor to make a very solid foundation wall—a monolith—capable of holding off all subsoil moisture or water; and besides, it admits of the construction of foundations under water at a considerable depth, without requiring the previous draining of the building ground. Not only for foundation work is this material adapted, but unusually solid buildings can be and have been rapidly constructed with it, and at comparatively little cost, both abroad and at home; indeed, it may be safely asserted that the use of hydraulic mortar has exerted a notable impression on modern architecture, inasmuch as it permits of the introduction of the most elaborate ornamentation by moulding, at a cost incomparably less than that involved in the treatment of the natural building stones.

The popular name of "Artificial Stone" is given to most of the artificial constructive materials employed for various building purposes on land, and although nearly all of these products contain hydraulic cement as their principal ingredient, the distinction is a useful one.

Mr. William Krause, whose thorough acquaintance with the nature of cements and the art of manipulating and employing them is attested by a practical experience, both abroad and in this country, extending over twenty-five years, is especially worthy of mention in connection with the foregoing remarks, inasmuch as he has, by persistent effort during the many years of his residence here, no less than by the invariable excellence of the work performed under his superintendence, done more, perhaps, to popularize the employment of artificial stone for the vast variety of domestic uses for which it is eminently adapted, than any other person. Mr. Krause was for years engaged in the business of manufacturing artificial stone in Germany, where it has long since grown to the proportions of an important industry, under the direction of trained and scientific superintendents, and established the works for the manufacture of the several varieties of cement stone in New York City, in the year 1868. He shortly after removed his establishment to Philadelphia, and prosecuted his business with such good results, that one of his pro-

duct, which bears the name of Lithogen, has acquired a wide popularity for its excellence, and can be affirmed to be unsurpassed by any artificial stone ever devised for similar purposes. In the year 1873, letters-patent were issued to Mr. Krause (in connection with W. H. Krause, Jr.) for improvements in laying concrete pavements. Said improvements consisted in a peculiar division of the concrete mass, which it is the usual custom to apply in one undivided layer, into blocks of convenient size, a device which obviates one serious objection which had heretofore existed against the employment of artificial stone for pavements, &c., inasmuch as, each block being separate and disconnected from the others, the improved system of Mr. Krause permitted the taking up and relaying of the pavement, whenever it might become necessary to get at the gas or water pipes for repairs, or to lay drain pipes into the street, &c. With regard to this artificial stone pavement, it may be remarked that it is steadily growing in popularity, its excellent qualities, on the score of hardness and durability, becoming more and more apparent with its use.

The materials employed by Mr. Krause are said to be German Portland cement (of first quality), and sometimes the best English cement, with sand, the proportions varying somewhat according to the requirements of practice. In durability it exceeds most of the natural stones, and is surpassed by none. Aside from its excellent wearing qualities, the cheapness of the artificial stone is particularly worthy of the attention of intending users, since it can be furnished at a cost decidedly lower than the natural building stones. For masonry work of every description, requiring to be water-tight, it is unequalled, its peculiar fitness for such purposes having been fully touched upon in the introduction of this article. This will especially apply to such manufacturing and domestic uses as floors for malt-houses, stables, breweries, ice-houses, slaughter-houses, oil-cisterns, cellars, &c., and also for the plastering of floors and walls of houses to prevent dampness and its attendant evils—and, to state the case briefly, it is peculiarly suited for the protection of all places and situations which require to be water-tight.

Mr. Krause is likewise about producing a cement pipe for general hydraulic purposes. He has introdnced also the idea of coloring the artificial stone blocks of various colors, by the use of which a variety of ornamental and decorative results may be attained.

He claims the distinction of having established the first works for the manufacture of artificial stone in this country, and while it would be invidious to institute comparisons, the character of the work done under his superintendence will best speak for itself. Those who have become interested in these remarks, may take the opportunity of examining this point for themselves, by obtaining from the works a circular. which contains a formidable list of names and localities where the Krause stone has been introduced, and the opportunity of personal inspection will be thus afforded. For all further information, or for negotiation of State and county rights to work the Krause patent, apply to the First Artificial Stone Works, office No. 618 Sansom street, Philadelphia.

CENTENNIAL.—THE DOMESTIC SEWING MACHINE CO., Apt at expedients, has enclosed its space with left hand machine legs, capped with a black walnut railing. The word "Domestic," in gilt letters on each one, makes a sign that is at once appropriate and striking. A large glass case within contains a wax figure (life size), decked in garments put together and trimmed upon the machine. Upon this case stands a machine, surmounted by a large stuffed eagle, with outstretched wings. That eagle evidently thinks that the dissemination of the Domestic is widespread.

THE AMERICAN WATCH CO., OF WALTHAM, MASS., Has exquisite machinery to show, as far as possible, its method of making watches.

Four men and fourteen girls are at work in the different departments.

Two automatic screw machines each turn out daily 5,000 microscopic screws—140,000 to the pound.

Another machine shows the method of "damaskeen" ornamentation on nickel plate.

Four machines are employed in preparing ruby jewels.

The company, at its factory, turns out daily 350 watches; of which, about 2,000 per month are exported to London.

About 950 workmen are employed.

THE ECLIPSE PATENT STEAM INJECTOR.

It is essential that the supply of feed-water to steam boilers should be effected by means of some simple, durable, and inexpensive device, which shall heat the water as hot as possible without wasting steam for the purpose of heating or supply. Not many years ago this problem would have been laughed at as impossible of solution, and yet the cut presented herewith shows very comprehensively the construction of an apparatus which accomplishes *all* that is desired in the way of boiler feeding.

It is on the principle discovered by Giffard, of a fine jet of steam carrying by force before it a jet of water, with which it becomes condensed. But in the Eclipse injector, all the intricate spindles and valves of the Giffard are wanting, the working parts being but *three* in number! There is an external casing; an internal brass tube, with suitable nozzles and passages; a sliding spindle to regulate the supply of steam, and very little else, save the necessary steam and water connections. By unscrewing a nut these working parts may be easily taken out, separated, examined, cleaned, and put back in one minute, without breaking any of the connections. It works under any steam pressure, from 10 to 200 pounds, and will lift its water as high as any other. When it becomes necessary to refill the boiler with cold water after cleaning out, by closing the overflow *d*, and removing the working part, the water from the tank or reservoir will flow through, the opening being the size of the connecting-pipe.

Fig 2.

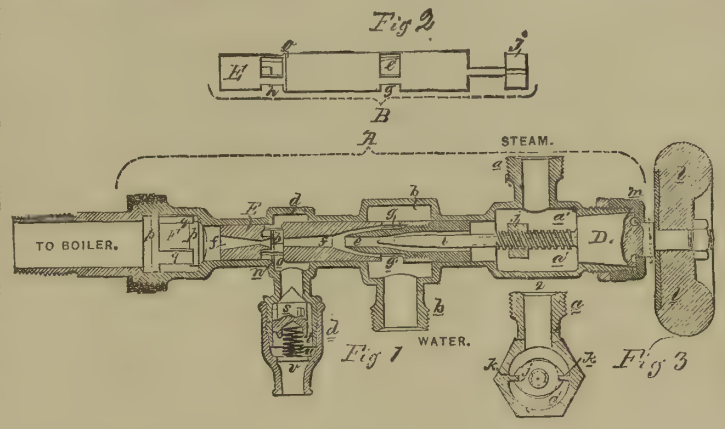


Fig 1 Fig 3

The water is heated to 200° Fahrenheit, hence no heater is necessary.

No steam is wasted as with a feed-pump; but that used is returned to the boiler.

For locomotives, this device is particularly desirable, as by simply turning in the regulating valve tight, it then throws the steam into the water tank, heating the water and obviating the danger of freezing in winter.

This injector may be taken apart while a full head of steam is on.

This simple and effective device is made by the Pennsylvania Brass Works, 1226 and 1228 Hamilton street. Office, 23 Merchants' Exchange.

The company makes all its own brass-work and also does work to order.

In supplying the Eclipse Injector to the trade, a duplicate stem is furnished, thus practically making two injectors.

The company has large works, and is at present very busy in supplying orders.

The company's exhibit at the Centennial consists of a full set of injectors, one of each of twelve sizes (8 to 500 H. P., or ¾ to 66 gallons per minute), and handsomely enclosed in a walnut case, lined with velvet. This will be in space 5422, Machinery Building. Besides this case for exhibition, the injectors are entered for competition, and will be in operation in the Boiler Annex to Machinery Hall, on one of the boilers.

The injector is patented in Great Britain and the United States.

MAREZZO MARBLES.

Those who have occasion to visit St. George's Hall cannot fail to admire the beauty and fidelity to nature of the columns and pilasters of Scagliola marble used in its decoration.

It is not surprising that the Scagliola and Marezzo marbles are meeting with favor, when we consider that real marble (wherever the cost of decoration is immaterial) is so universally sought after and admired. Its beautiful veining, close grain, hardness, and consequent susceptibility of taking a high polish, seems apparent to all.

The ruins of the temples of Apollo and Minerva, the Parthenon, the Hippodrome, and others, still fill us with wonder and admiration, and attest to the favor in which it was held by the ancients.

The Romans, who, in all their buildings, sought to combine elegance and vastness of design with the greatest durability, adopted the use of marble from the Greeks. Its use soon became general, both public and private, and the rich patricians vied with each other in its use to embellish their buildings, laying the whole, then known, world under contribution to furnish them with the richest, rarest, and best marked specimens.

More recently, the dome of Milan, the cathedrals of Genoa and Pisa, the leaning tower of Pisa, the Walhalla near Ratisbonne, the church of Santa Croce, at Florence, and others, have been built of marble. But the use of natural marble is, and until richer deposits are found, and better facilities for working, transportation, &c., are developed, must remain very expensive, and accessible only to the few.

The masses, many of whom appreciate elegance and refinement, must despair of living in marble palaces or being surrounded by marble ornamentation. To these the Scagliola and Marrezzos will be of interest as a triumph of modern science and art, placing within the reach of all a substitute in certain respects superior to the natural product.

These imitations are closer grained, and less easily affected by atmospheric, chemical, or gaseous influences, which soon mar the beauty and affect the permanence of all but the very best grades of marble

In the hands of a skillful manipulator, they come out so finely polished, so faithful in veining, coloring, and general appearance, as to deceive any but an expert. As the veining enters into the composition of the mass to the depth of at least one-fourth of an inch, fractures can be easily repaired in such a manner as to leave no perceptible trace.

The cost of the imitation is often not one-tenth that of the natural stone.

Perhaps its best eulogium is to be found in the terse and pithy expression of Mr. Morton Edwards, Secretary of the Society of Sculptors, England, when he spoke of it as "an invention applicable to a paper weight or a marble staircase."

The discovery is comparatively new, but the Marrezzo has been used in the entrance hall to the Society of Arts, Adelphi, the columns of the Memorial Synagogue, Rochester, the corridor of Gray's Inn Chambers, Holborn, and many other handsome edifices.

Any one desiring further particulars, can doubtless learn them from James T. Allen & Co., No. 25 North Seventeenth street, who fitted up St. George's Hall, and to whom we are indebted for a part of our information.

The company has a fine exhibit at the Centennial grounds, Main building, location T—54.

Trump Brothers, Wilmington, Delaware, manufacture the celebrated "Fleetwood" Scroll-saw. Have been manufacturing for three years. Are running tolerably busy. A number of their machines will be on exhibition in Machinery Hall—two of them in operation. This machiue is the patent of the firm, and is intended for fine scroll-work in wood or metal; is especially adapted for manufacturers of fine furniture, jewelry manufacturers, and for all work requiring fine artistic patterns or intricate shapes. Over four thousand of these machines have been sold, not only in this country, but a large number have been shipped to all parts of the world. Quite a number have been taken by Army and Navy officers.

S. J. Rose & Son, Chester, Pa., manufacture a first-classe article of hand-made front and common brick. This firm has been established twenty years; owns ten acres of ground, containing five beds of clay and moulding sand. It has three large kilns, and a large amount of shed-room; employs 30 hands, and has a capacity of 100,000 bricks per week. Having excellent shipping facilities, it does ship largely to a number of towns in New Jersey and Delaware, and is now supplying a quantity of material for the erection or repairing of batteries at Fort Mifflin.

Messrs. Cramp & Sons, Philadelphia, are altering an iron vessel 204 feet long, 35 feet beam, 22½ feet depth (draft 14 to 17 feet), by lengthening her with 48 feet amidships, and adding an upper housing.

The same firm is building, at the foot of Palmer street, a dry dock (J. E. Simpson, patentee and contractor), which will be at once a convenience and a credit to Philadelphia. This dock is 432 feet from the head to the gate in the outer groove, 420 feet on the keel-block line; is 3 feet above high water; contains 5,000,000 gallons of water, and will accommodate a vessel of 4,000 tons. It will be emptiable in 60 minutes, by four centrifugal pumps (W. C. Hibbard's patent), built at the Atlantic Works; each pump having a capacity of 30,000 gallons per minute. The four pumps are driven by two vertical engines, 18×20, each with a 9 feet spur-wheel on the driving-shaft, gearing into a 3 feet pinion on the pump-shaft. There are two boilers, each of 150 (maximum) H. P.

Bowers, Dure & Co., of Wilmington, Delaware, have mad twenty-seven elegant passenger cars for the new line between Philadelphia and New York, and the works are running very briskly, with a large force of men.

CENTENNIAL NOTES.—*Continued.*

McKechnie & Bertram, Dundas, Ontario, have a slotting-machine and a large radial drill, a wood surfacer and a power lathe.

I. J. Fisher & Co., Kincardine, exhibit a cutting press.

Lordly, Howe & Co., St. John, N. B., a gauge lathe.

W. Kennedy & Son, Owen Land, Ont., wood planer.

G. P. Drummond, Ottawa, shows a type-distributing machine; capacity 12 to 15 thousand ems per hour.*

James Harris & Co., St. John, N. B., Leffel turbine.

George Fleming & Sons, St. John, N. B., small vertical oscillating engine.*

G. Hermann, Paris, stone chocolate rollers and mills.

Moraine, of Paris, has a fine horizontal hydraulic hot press; a hydraulic cylinder for pressures up to 800 atmospheres, and a machine for finishing wax candles.*

Automatic Book Sewing Machine Co., Milton, Mass., book stitching machinery.*

J. Morton Poole & Co., Wilmington, Del., have on exhibition two stacks of chilled calender rolls, ground by their patent process.*

The great Corliss engine has been running at full speed, with the most gratifying results as regards smoothness and absence of noise.*

George B. Holmes, Buffalo, N. Y., full line of barrel making machinery.*

Cornell University, Ithaca, N. Y., Gramme Dynamo-electric machine, sets of surfacing plates, screw-cutting lathe, &c., built by the students.*

SWEDISH DEPARTMENT.

We note a 20 H. P. horizontal compound engine, built by the *Kockum M. V. A. B.*, of Malmö, but of too expensive construction. Frame-work, which in an American engine would be cast in one piece, is here in several, with carefully planed end-faces bolted together. There is a smaller horizontal engine finely finished.*

Mr. H. Asplund has a very compact vertical compound marine propeller engine of 12 H. P., on Woolf's system, and with the condenser in the housing. The eccentric is reversed by a geared worm and wheel.*

A very curious governor, by Prof. R. Rundquist, and not yet in place, seems to be upon the gyroscope principle.*

A finely finished machine for manufacturing metallic cartridge-shells, and a companion which equalizes the size of the bullets and fastens them in the filled shells, will be in operation in the Bollinder's space.*

Some bars of Dannemora crucible-steel are of exquisite texture and quality.*

A pair of mounted car-wheels from the Surahammar Works, are worthy of special note, as having run 125,500 English miles, upon the very rough Swedish tracks, with the slightest perceptible wear. They have wrought iron-iron hub and spokes, welded within a wrought-iron tire. A specimen of the iron in these spokes is shown, bent 4 times cold, as shown in the sketch. It is 30″ long and $3\frac{1}{2}'' \times \frac{3}{4}''$ in section.

Dr. G. Zander exhibits a very interesting and well-finished series of apparatus for use in the "Swedish Movement" cure. There are screw-stools, apparatus for "vibration," "friction," "percussion," arm-twisting, hand-flexion and extension, leg-flexion, leg-abduction, foot-rotating, chest-spanning, &c., besides a "combined mechanical gymnasium"—*multum in parvo.**

H. Asplund exhibits a Tank Locomotive of 3 feet gauge. The valve-chest is considerably inclined in the vertical plane, to the cylinder-axis; the fire doors are sliding; the ash-pan has hinged flies fore and aft for draft and clearing.*

The Messrs. Bollinder exhibit heaters for schools, dwellings, &c. In these, the air may be drawn from the room to be heated, or from without, by throwing a damper; the air to be heated passes both through and around the fire-box and smoke-flue, by means of iron pipes with projections cast upon their faces to increase the heating surface. The smoke-pipe finally passes through a ventilating flue, causing a draft in the latter.

The samples of Swedish iron are really more than admirable; they are *wonderful* in their texture, beauty, quality and strength.

The "Perpetual Kilns," of Paul Loeff (Berlin), will be exhibited both in the Main Building and in Machinery Hall, and will receive accurate and detailed description in our columns as early as practicable.

The Franklin Institute has, through the kindness of the Centennial Commissioners, opened a Reception Room, at the north-western end of Machinery Hall, for the use of its members, and visitors from abroad, interested in the Mechanic Arts. The Institute cordially invites all who desire to do so to visit its room, in which will be found files of the Journal of the Institute and other periodicals devoted to the Industrial Arts. The room is in charge of a committee of twenty-six members of the Institute, one or more of whom will be in attendance daily during the exhibition, to receive visitors and to give any information they may desire in reference to the exhibition. The chairman of the Reception Committee is Mr. J. E. Mitchell.

KEYSTONE PRESSURE BLOWER.

The cuts show the centrifugal, fan, and pressure blowers, and exhauster, made by the Keystone Portable Forge Com-

Fig. 1.

pany, of this city. The blowers are shown in Figs. 1, 2 and 3. Each blade or wing has at its base a spur or cut-off, and on each side a flange connecting with the spur. These blades and spurs are of steel, firmly secured to a series of steel or brass "spiders," through the exact centre of which runs the shaft, of tool-steel. The bearings are iron or brass bushings, lined with the anti-friction compound "metalline;" running cold, requiring no oil, without perceptible friction, wear or noise.

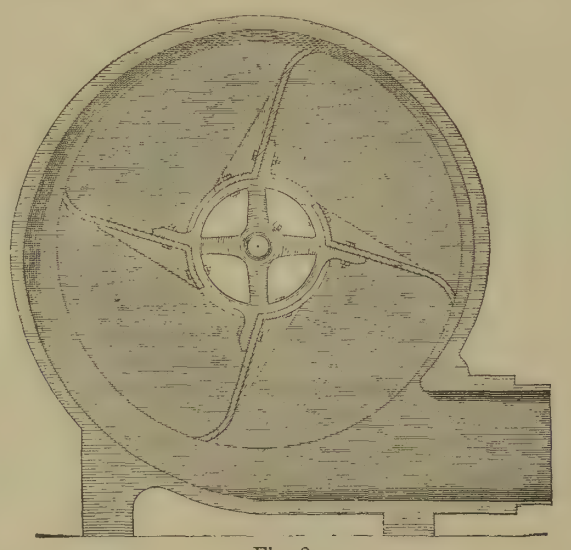


Fig. 2.

Each bushing is fastened by a set-screw, the point of which rests in a spiral groove on the upper face of the bushing. Should the shaft require adjustment, this set-screw is loosened, and the bushing slightly turned.

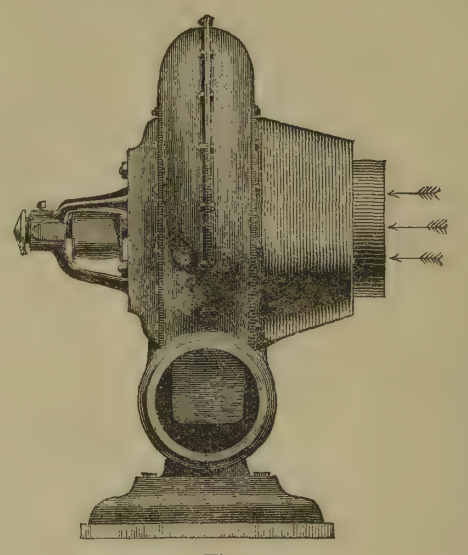


Fig. 3.

The great width of the breast-wheel at the juncture of the blades and spurs, gives these blowers greater volume than those having fans of equal diameter but less width. The pressure of blast is claimed to be greater than that produced by other centrifugal blowers running with equal power.

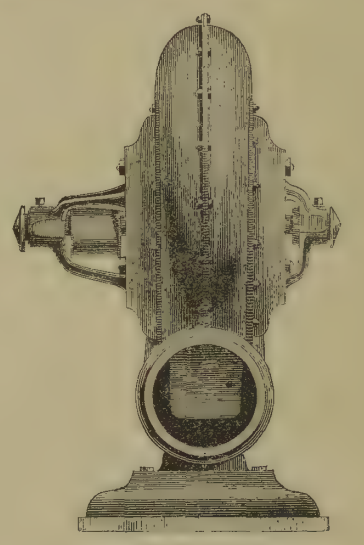


Fig. 4.

Fig. 4 shows an exhauster suitable for gas-works, for mines, exhausting dust, shavings, &c. The office of the company is at 120 Exchange Place, Philadelphia.

RIEHLÉ BROS.
SCALES,
Testing Machines,
BEAMS, &c.
IN ALL VARIETIES.
Office and Works,
Ninth Street above Master.
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THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. 1. PHILADELPHIA, JUNE 20, 1876. NO. 5.

GREGG'S "TRIPLE-PRESSURE" BRICK MACHINE.

While there are many machines which will turn out lumps suitable to be burned into inferior bricks, the attempt to successfully imitate and compete with the hand-made product for face or front bricks, have, in general, met with indifferent success. The fault lies just here: It being very difficult to regulate the amount of clay fed into the moulds, so that an *absolutely equal* amount shall be compressed at each successive filling, we find, ordinarily, a variance either in the *thickness* of thebricks, or in their *density*.

The brick machines before the public—and there are ten or more kinds exhibited at the Centennial—may be classed as Dry Clay, Wet Clay or Slush, and Crude Clay Machines. The Dry Clay Machines pass the clay (after being dried and granulated) into filler boxes or graduated measures. It is certain that by this means, equal filling in groups of moulds is impossible; and manyimperfect blocks are the result. Further, by driving out all the water, the opponents of the dry clay system claim that the material loses its plasticity, and the bricks so made are incapable of standing the weather.

In the wet clay system, hand moulding is facilitated by the addition of a large proportion of water, which is afterwards removed by out-door drying.

This last process necessitates a large drying area and is dependent upon continuous favorable atmospheric influences not to be relied upon. Hand-made bricks, from which 25 per cent. of water must be evaporated before it is safe to burn them, necessitate the evaportion of about 23 tons of water from a day's run of 30,000 bricks. This evaporation is attended with an expense all the more unsatisfactory because its only effect upon the bricks is to render them porous.

In the operation of the Triple-Pressure brick machine, the inventor believes in taking a position between the dry clay and the so-called slush machines. In this, Mr. Gregg's object is to effect a first great saving in accepting the crude clay and manufacturing it to advantage in so stiff a state as not to contain more than one eighth the above-named amount of water to be evaporated, while yet retaining all of its cohesive qualities. If, by this means, perfect burning is ensured, the bond between the particles will be closer, and the burned bricks less porous, and consequently stronger, and less absorbent of moisture.

Hydraulic tests, made by J. B. and W. W. Cornell, show a marked superiority in strength of the Gregg brick over the hand-made product.

The same tests being applied by the direction of the U. S. Supervising Architect, at the Treasury department, with the same results, the Gregg brick was ordered to be used in the government work.

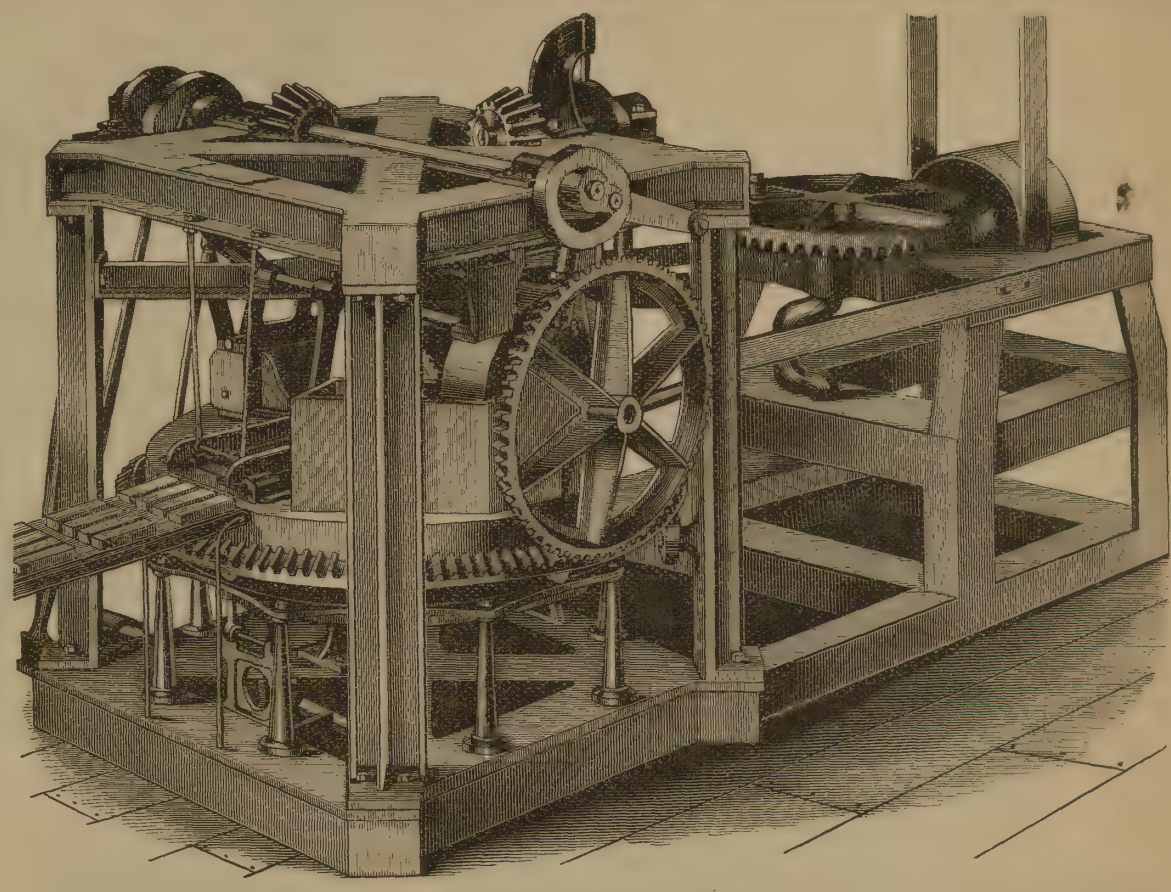
The machine has a circular mould board which rotates intermittently, and which contains eight sets of moulds with four in each set, making thirty-two in all. A set of moulds being automatically filled with crude clay (by agitators in the hopper), passing then under a roller, the clay-filled moulds receive (1) a steady preparatory pressure. The excess is then removed by passage under a diagonally placed horizontal knife. Still further rotating, the filled moulds receive (2) an upward pressure by means of a toggle-joint; (3) a double pressure from above and below, by means of cams and toggles. At this stage, one of the most ingenious features of the machine comes into play. Any variation in the quantity of clay in the mould necessitating, in any machine, a variation either in the *density* or in the *thickness* of the bricks, such unavoidable variation must be overcome. This object the inventor successfully effects by *sinking a panel in the face* of each brick. By this means, any variation in density is prevented, and whatever compensating variation in *dimension* may be produced, occurs in the *depth of this panel.*

The maker claims that, by a pressure from both sides, the bricks are strong and perfect at the corners and edges; and that by giving the heavy developing pressures while the mould-board is at rest, but a nominal amount of power is required, and the great wear and tear and breakage in some other machines, avoided.

The machine is automatic in its operation—requiring but one man, for the purpose of feeding. The bricks are discharged on an endless belt or carrier, and taken directly to the kiln for burning, thereby avoiding the great expense of drying on floors or by artificial dryers.

Just how much is lost by having friable brick, varying in dimensions, (particularly in thickness) the builder can well understand; while the maker will appreciate the advantage of being able to produce, at a low cost for power and labor, perfect brick, ready for the kiln.

The "Gregg Triple-Pressure Brick Machine Company," at 402 Walnut Street, this city, desires investigation into the soundness of its claims.



Triple-Pressure Brick-Making Machine: W. L. Gregg.

"Masterpieces of the International Exhibition."

A working model of this machine may be seen in Machinery Hall Centennial Exhibition, at A. 10–75; and a full size machine in motion, in Annex No. 3, Machinery Hall.

THE SOLAR ENGINE.

The experiments of Bergh and Erricsson in the direction of utilizing the heat of the sun to produce mechanical power, derive an additional interest from the practical results obtained by Prof. Mouchet. This gentleman's first practical application of solar heat took the form of a cooking apparatus, which is affirmed to have operated very satisfactorily. From this point, the construction of a solar engine originated, concerning the history of which we give herewith the following account summmarized from the *Revue des Deux Mondes.*

"In 1886 M. Mouchet took the sun from the kitchen to the workshop, and at the cost of the Emperor Napoleon completed his first mechanical solar engine. An apparatus of this nature is now to be seen in the court-yard of the library at Tours. A conical silvered reflector, 26 metres diameter at the base, 1 metre at the apex, and 8 centimetres high, exposes 4 square metres of reflecting surface. The angle of the inclination of the sides of the cone to the axis is 45 degrees. The boiler placed in the focus of this hollow cone is double, being in fact a mere shell. The outer coat has a longitudinal diameter of 80 centimetres, and a tranverse diameter of 28 centimetres, while the corresponding dimensions of the inner coat are 50 and 22 centimetres. Thus a shell of water of 3 centimetres in diameter is subjected to the reflected heat; the contents of the boiler being twenty litres of water, with a steam box containing ten litres of cubical space. The vacant space within the inner coat affords room for the steam and water pipes and for the safety-valve. A bell glass of five millimetres thick (or $\frac{2}{16}$ of an inch) is constructed so as to surround the boiler concentrically at a distance of five centimetres (or two inches). The object of this transparent envelope is to allow the free passage of the visible rays of light and heat that come from the surface of the reflector, and to arrest the invisible thermic rays that radiate from the blackened surface of the boiler. The latter is thus constantly surrounded with a cushion of heated air, excepting at the foot, where it is joined to the reflector. A clock-work apparatus is attached, by means of which the axis of the apparatus is kept continually directed towards the sun. The apparatus in question was erected three and a half-years ago, by aid of a subvention from the Council-General of the Department of the Indre and Loire. The results merit attention. On the 8th day of May, 1875, the day being fine, 20 litres of water at a temperature of 20° Centigrade were placed in the boiler at 8.30 A. M.; in forty minutes steam was generated, with a pressure of two atmospheres, which gives the calculated temperature of 21° Centigrade above boiling point. The pressure rapidly rose to five atmospheres, which was that at which the safety-valve was weighted, as at this heat the sides of the boiler have to support a total pressure of 40,000 kilogrammes. Towards the middle of the same day, 15 litres of water at the boiling point were raised in less than fifteen minutes to a pressure of five atmospheres, equivalent to a temperature of 153° Centigrade. On the 22d of July, about 1 P. M., the apparatus converted into steam five litres of water per hour, which is equal to 140 litres of steam per minute, or to about one-half of a horse-power.

GREGG'S CERAMIC GAS KILN.

The accompanying engraving represents very satisfactorily the Ceramic Gas Kiln, erected at Gregg Station, Illinois. It is the invention of Mr. Wm. L. Gregg, whose Triple-Pressure Brick Machine is illustrated on our first page.

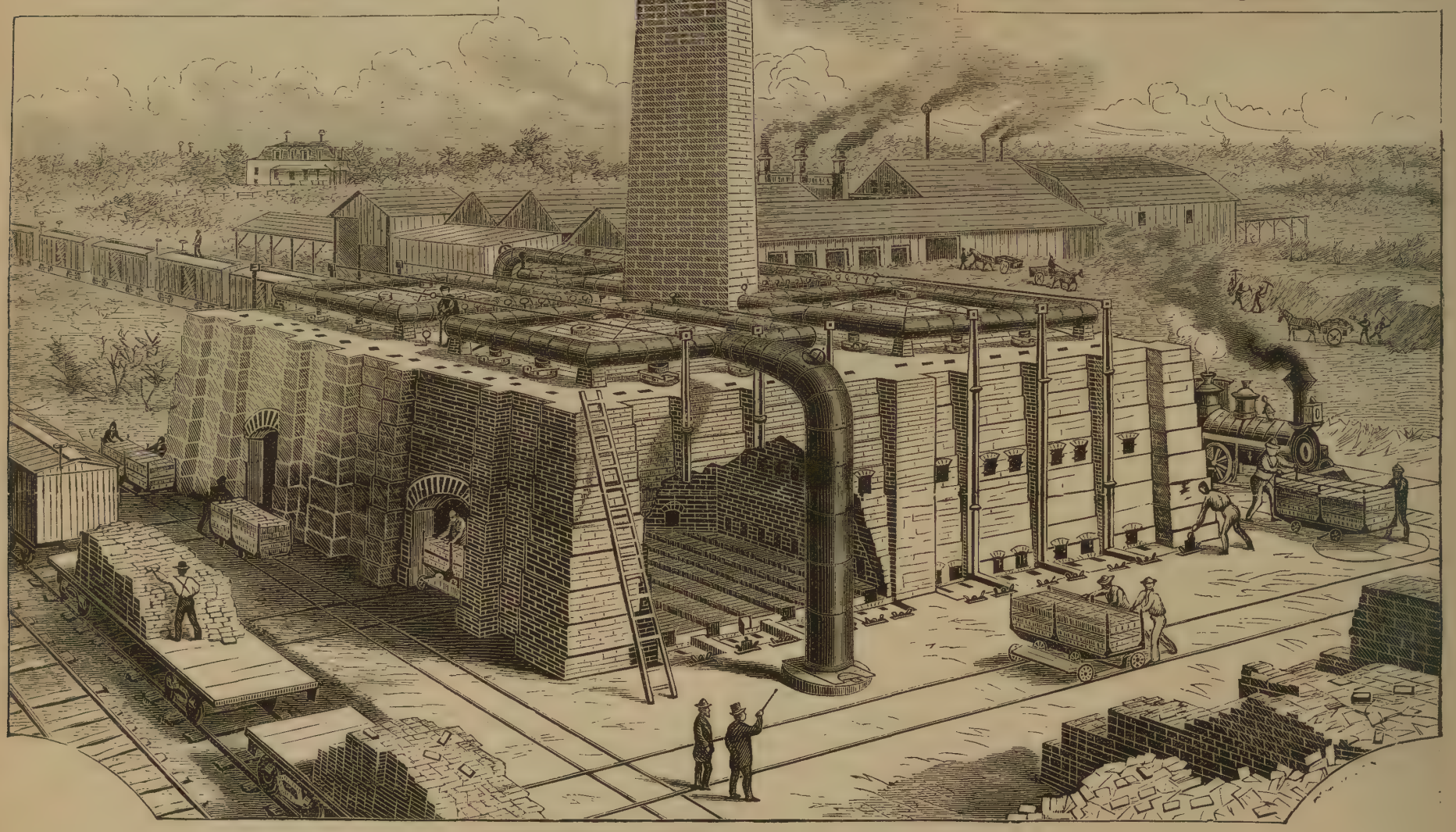
The desiderata of a kiln for burning bricks, pottery, etc., are rapidity, economy of fuel and labor, and, above all, *certainty* and *uniformity of product*. The ordinary temporary kilns, which are unsightly in appearance, and very roughly constructed, are so uncertain and irregular in their burning, that we cannot pardon their extravagance of fuel, and the amount of skilled labor required by them.

To meet the objection of extravagance in fuel, permanent kilns have been devised, and largely used in England and on the continent of Europe.

There still remains to most of these permanent kilns, the objection of irregularity or lack of uniformity in product. Few of these systems have made even an attempt to turn out product uniformly baked; in most of them, the product is of several grades of vitrification, and there is a very large per centage of wastage and "second quality."

In the kiln, illustrated herewith, two very good principles are adopted—the use of gas as a fuel, and the "continuous chamber" system. In addition, a most important feature is added—a "reversible draft," so that, by means of a series of dampers, not only each chamber may be connected with the central stack or chimney, but each chamber may be burnt, first with an upward and then with a downward draft, securing evenness of heat-distribution, and reducing the wastage and inferior products to a minimum.

The fuel is gas, produced at a nominal cost from the refuse of coal mines, and giving a better combustion than the most expensive grades of coal and wood.



GREGG'S CERAMIC GAS KILN.

Mr. Gregg claims for this kiln that the time, fuel, and labor saved thereby, reduce the cost of burning below one half that by the old method; that the product is uniform, and of enhanced value; and that the best qualities of pressed brick and all other clay products may be perfectly burned without loss from over or under burning.

A model kiln can be examined in Machinery Hall, Centennial Exhibition; and full details of cost and construction obtained at the Office of the Company, 402 Walnut Street, Philadelphia.

THE REMOVAL OF NIGHT-SOIL.

IV.

In our first article in the *Review* for February 10, we divided the modes of disposing of night-soil into three classes:—the well-system; washing away by water; and absorption or neutralization. The utter nastiness and unhealthfulness of the well-system we have very plainly described, some precautions and improvements suggested, and "odorless excavation" commended as a partial mitigation of one of its evils. The water-closet system, "designed more as a convenience than as a sanitary substitute," was described, and a system of positive ventilation illustrated in detail, with a view to preventing offense from escaping gases in the house. Where there is a cesspool receptacle for the matters from the water-closet, ventilation and odorless excavation are recommended.

We come now to the consideration of the third-mentioned system of disposal of the *excretæ*:—absorption or neutralization. We must commence by noting the difference between a *preventive* and a *cure:* and by premising that no one, after a moment's reflection, would class among sanitary agents any mode of overcoming one smell by another, merely more powerful. We will take the case of sick-room *excretæ*. An ancient and abominable usage—or *ab*-usage—was to burn rags or some equally odorous material, to counteract the effect on the olfactories, of the unpleasant matters. The use of chloride of lime or other *disinfectants*, neutralizes the smell already existing, and at the same time destroys all further capacity for contamination. It is a cure. Carbolic acid not only neutralizes the odors existing, but prevents the formation of others. This last is an antiseptic or preventive.

But all these modes have the disadvantage of being "unsavory medicines." Copperas is disinfecting, and gives off no odor; but is inconvenient in use, and stains the receptacles, &c. Furthermore, where chloride of lime, carbolic acid, copperas, or their cognates, are used, the resultant matters are troublesome to dispose of, and of no utility.

Is there not, then, some mode by which unpleasant odor and effects may be prevented, by a system of itself devoid of offense, and giving a product easy of disposal and of value to mankind?

The sluggard is advised to "go to the ant" for instruction. The sanitarian may with advantage be referred to the common cat. This animal,—the nicety of whose person, and the offensiveness of whose fœcal discharges, are proverbial—teaches a lesson in decency and in sanitation, well worthy our attention and memory. A simple and instructive application of absorbent earth so completely *prevents* contamination of the air, as to prove at times a trap for the unwary. Earth is a wonderful *absorbent*, and is the occlusion of unwholesome matters, of increased value, as *soil*, while "devoid of offense."

Here, then, we have the key to a system of removal of night-soil likely to accomplish, by means close at hand, two things: the *prevention* of unpleasant and unwholesome odors, and the *production* of a neutral substance, easy to remove, and of intrinsic value. Dry earth, coal-ashes, charcoal, peat, etc., are excellent absorbents and deodorizers. It only remains to provide a means for the perfect, easy and enforced *appliance* of these absorbents; and the removal and use of the product. To the Rev Mr. Moule, an English clergyman, is due the invention and introduction of the "*earth-closet;*" Colonel George E. Waring, Jr., of Ogden Farm, aided greatly its presentation to American notice; while to Mr. Charles A. Wakefield, of Massachusetts, is due the credit of having made such marked improvements and adaptations in the device, as place the earth-closet in a position to deserve public confidence.

Fig. 20 is a perspective view with the seat a little raised; Fig. 21 a horizontal cross

Fig. 20.
THE WAKEFIELD EARTH-CLOSET.

section just below the seat; and Fig. 22 a central vertical section. Like letters refer to corresponding parts in the three figures.

A is a chamber or receptacle in which the earth is placed; or, in lieu of earth, coal-ashes or similar substances may be employed. A device is connected with the closet,

Fig. 2

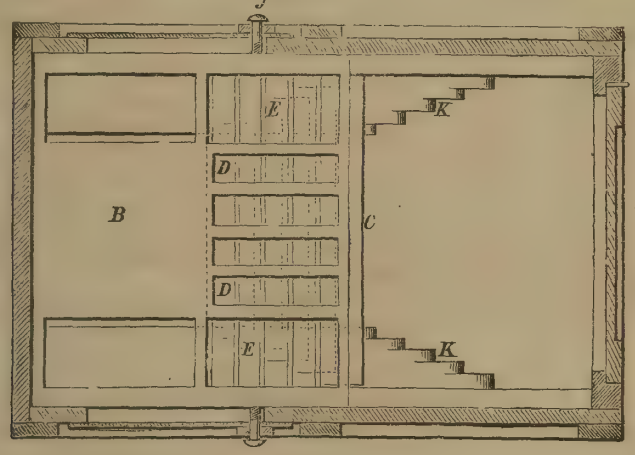


Fig. 21.

but is not shown, by means of which these substances can be deposited in the chamber with no escape into the room where this commode is placed. At the bottom of this chamber is placed a metallic slide, B, and when the commode is not in use this slide is drawn forward, as seen in Fig. 22, and forms a bottom to the chamber, A, fitting close

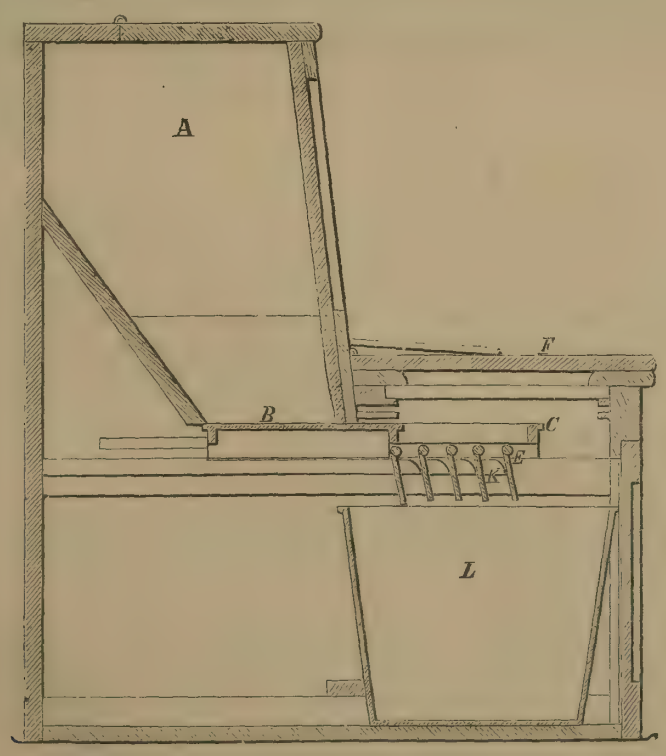


Fig. 22.

to its edges. The front portion of this slide, as shown at C, consists of shallow chambers, D, which are recessed, and are closed by means of the pivoted slats as shown at E. In Fig. 22 these slats are shown as being dropped down, which position they assume by their gravity on being drawn forward a sufficient distance.

When the lid, F, is raised, a rod, G, actuates the lever, H, which is pivoted at I, near the upper portion of the chamber, A, and, engaging the pin, J, which projects from the metallic slide, B, compels a backward motion of B, and brings the recessed chambers, D, under the chamber, A, where they are filled with earth. The slide, N, serves to close the slot underneath it in the chamber, A, in which the pin, J, operates, and so prevents the escape of odor and exhalation. Earth is retained in the chambers, D, by the closing of the slats, E, which are raised by becoming engaged with the steps, K, as the seat, F, is raised.

In closing the lid, reverse of the movement described takes place. By the forward action of the rods, G and H, and the stud, J, the plate, B, is thrown forward, the slats, E, become disengaged from the steps, C, drop down, and the contents of the shallow recesses or chambers, D, are discharged into the bucket, L, covering its contents completely and with certainty.

To prevent the rise of dust or offensive odor from L, there is a slide made to entirely close the opening in the seat, and is by means of links operated by raising one of the knobs shown at M, Fig. 20. Another slide with a small opening for children is operated in like manner by another knob, also designated by M, and moved by similar link-work. Depressing these knobs, either by the hand or as will be the case by closing the lid, F, slides back the cover or the child's seat, whichever one may have been operated.

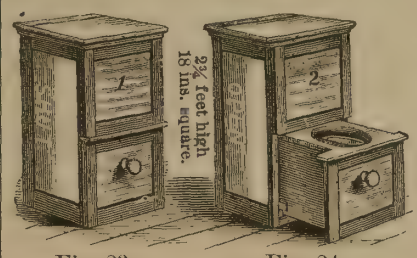


Fig. 23. Fig. 24.
THE CABINET EARTH-CLOSET.
Height, 2 feet, 10 inches.

The following are the dimensions: 3 feet high to top of reservoir, 2 feet 7 inches from front to rear on the floor; two feet extreme width.

Figures 23 and 24 are on a smaller scale than the preceding. The earth-reservoir is of full size; the pail somewhat smaller, and requires more frequent emptying. The Cabinet earth-closet is without the child's seat and dust slides; but it has all the essential parts; its only defect being the liability to dust on the seat. Pushing in the seat works the earth-valve.

"Once filling the reservoir will furnish a supply for a family of five persons for three weeks, under ordinary circumstances; and the pail containing the excrement will need to be emptied but once a week. One barrel of ashes will last six weeks, and in country places, the best method of saving the excrement through the year, is in barrels, under cover, until needed in the spring.[1] Every family will then find itself possessed of a dozen barrels (more or less) for fertilizing purposes, as valuable as guano, and equal in value *annually*, to the original cost of the EARTH-CLOSET."

Prof. A. B. Palmer, of the Medical Department of Michigan University, states the advantages of the earth-closet as follows:

"1. A comfortable closet on any floor of the house, which may be supplied with earth and cleansed of its deposits without any annoyance or inconvenience.

"2. A portable commode in dressing-room, bed-room or closet, the care of which is no more disagreeable than that of a stove.

"3. A convenience for the use of invalids, which greatly facilitates nursing.

"4. The removal of the most fertile source of typhoid fever and various other diseases.

"5. The complete suppression of the odors which, despite the comfort and elegance of modern living, still hang about our cess-pools and privy-vaults, and attend the removal of their contents.

"6. The complete deodorization of the bucket commonly used in jails and prisons.

"7. The utilization, under favorable circumstances, of a fertilizer of material value."

"To the political economist the dry earth system is a discovery of inestimable value. All human excrements by this process may be utilized and made of enormous value as fertilizers. Competent authority estimates the loss at $400,000,000 annually, in this country, occasioned by the heretofore imperfect utilization of excrementitious matter."

†

(*To be continued.*)

[This series of illustrated articles on the Removal of Night-Soil, was commenced in the March number of the "*Review.*" In article I, were described three systems of "Odorless Excavation;" in No. II, the pipe system was illustrated; in No. III, a ventilating system was described.]

THE PARIS EXHIBITION IN 1878.

The commission of the *Exposition Universelle*, to be held in Paris, in 1878, has published a communication embodying the general regulations of the exhibition. The following classification of the exhibits has been decided upon:—the fine arts; education and instruction; mines and metallurgy; the chemical arts; leather, caoutchouc, paper; textiles; articles of fashion and fancy; ceramics, glass, etc.; furniture; works of metal; telegraphy, optics, horology and instruments of precision; acoustics and music; industrial designs and photography; civil engineering; military art, weapons of war and of the chase and fishing; the mechanic arts, machinery; hygiene, medicine and surgery; food; agriculture; horticulture; inventions, discoveries (miscellaneous); and finally, exhibits representing the amelioration of the moral and material condition of mankind.

The usual regulations regarding conveniences to exhibitors, free entry of goods, etc., will be observed. One hundred grand medals of honor will be awarded by the administration, on the recommendation of an international jury. The other awards will consist of medals of gold, silver and bronze, and of certificates of honorable mention. The number of these will be limited and they will be awarded by the juries of the several groups.

The decree of the French government has fixed the opening of the exposition on the 1st of May, 1878. [*Moniteur industriel belge*, iii, 226.]

THE TUNNEL UNDER THE ENGLISH CHANNEL.

"It was estimated by Capt. Tyler in 1873 that between 300,000 and 400,000 persons yearly crossed the English channel at Dover, that the number was constantly increasing, and that if a tunnel were built it would probably be doubled. The idea of a tunnel under the channel was first broached by M. Mathieu, a French engineer, who laid plans for one before Bonaparte, in 1802. Owing to the subsequent disturbances the projector and his plans were lost sight of. Subsequently plans were proposed by M. Thomé de Gamond, Dr. Payerne, Messrs. Franchot and Tessier, Favre, Mayer, Dunn, Austin, Sankey, Boutet-Hawkins Simpson, Low, Boydon, Brunlees, Waenmaker, and others. To M. Thomé de Gamond is con, ceded the credit of pushing the project to its present advancement. In 1872 the present channel company was incorporated, Sir John Hawkshaw, Mr. James Brunlees and M. Thomé de Gamond being appointed the engineers. The route finally adopted places the tunnel on a line drawn from St. Margaret's bay near the South Foreland, on the English side, to a point between Sangatte and Calais, in France. The total proposed length of the tunnel is 31 miles, of which 22 miles will be under the channel. Should the preliminary tests prove favorable, it is proposed to begin the actual construction by sinking shafts on either shore to the depth of 450 feet below high water mark. Driftways will be driven from the bottom of these for the drainage of the subsequent tunnel proper. The tunnel, if constructed, is to begin 200 feet above the driftway, and will be driven from both ends. It is to be through the chalk, and in no part of it will there be less than 200 feet of ground between the crown of the arch and the bed of the channel. It will be on a down grade of one foot in eighty to the junction of the drainage driftway, and then on an up grade of one in 2,640 to the middle of the strait. It is proposed to drive the driftway or heading with Dickinson Brunton's machine for tunnelling through chalk, which works like an auger boring wood. It is believed, from actual work done, that this machine will advance at the rate of from a yard to a yard and a-quarter an hour. At this rate it would require two years to construct the driftway, driving from either end, at an estimated cost of £800,000. After the heading has been driven through, it has been estimated that four years time and an outlay of £4,000,000 will finish the work, including arching; but Sir John Hawkshaw and his associates consider it best, before beginning the work, to double this figure as an estimate. The preliminary works to be undertaken are the sinking of two shafts at either extremity of the tunnel, from which an ordinary mining driftway ss to be driven about half a mile out under the sea, the cost of which is estimated at £160,000. This done, the engineers will be better able to judge of the ultimate practicability of the work." [From an article on Tunneliug (in Appleton's new edition of the *American Cyclopedia*), by Henry S. Drinker, E. M., of Philadelphia.]

Fig. 1.—TUNNEL BETWEEN FRANCE AND ENGLAND.

Fig. 2.—TUNNEL BETWEEN FRANCE AND ENGLAND. (Vertical Section.)

The engravings given, and for which we are indebted to the *Aurora Brazileira*, represent the plan proposed by M. de Gamond, having five shafts or ventilators with grand light-houses, three of these above the water, that of the centre having a dock for the refuge of vessels overtaken by storms.

A subaqueous tunnel has been planned, consisting of a cast iron shell lined with masonry, and sunk in 100 feet lengths, through a well in the centre of a pontoon 400 feet long, the sections being fastened together by divers.

Should the plan of directly driving a tunnel be found impracticable, there remain the two other plans proposed of connecting France and England: the one by a colossal bridge, and the other by a subaqueous tube laid on the bed of the channel. With reference to the latter project, Mr. Paul J. Bishop has proposed to lay two distinct tubes of cast iron in parallel courses on the bed of the channel, each tube to be laid with a single line of rails.

The route proposed would be from Dover to Cape Grisnez, between which points the deepest sounding is 30 fathoms, and the steepest gradient 1 in 100.

The whole length of this line is 21¾ miles, and the estimated cost about one million sterling per mile for two distinct tubes. The latter to be elliptical in section, four inches in thickness, and cast in sections of five feet, which will be bolted together internally through flanges twelve inches deep. The tube to be lined with brick-work laid in cement, twelve inches thick, and this again lined with sheets of five-eighths-inch boiler iron; the interior surface being thereby rendered flush and even throughout, so that either the locomotive or pneumatic system may be employed.

The outer dimensions of the tube to be 17 feet 8 inches on the major and 14 feet 8 inches on the minor axis of the ellipse, and the inner 15 feet and 12 feet respectively.

The weight, 273 tons of each 25 foot length of the tube, will be somewhat in excess of the weight of the water it will displace, so that it will remain quiescent upon the bed of the channel.

Before lowering, five sections of the tube will be bolted together into lengths of 25 feet, on board a pontoon or floating workshop, from which they will be lowered into position.

During the process of laying the tube, communication is to be maintained between the workmen above and below, and by them with the shore by electricity.

Assuming a length to have been lowered and fixed in position in connection with the shore works, a 25-foot length will be lowered directly in advance of it by means of slings and chains. The slings on the seaward side of the length of the tube assumed to have been laid, are provided with pulleys, under which are passed a set of hauling chains, the ends of which are attached to the slings on the shoreward end of the tube being lowered.

As soon as the latter reaches the end of the tube which has been laid, it is drawn towards it by the hauling-chains, which are operated from the pontoon and bolted to the section already laid.

The ventilation of the tube would require engines of 1000 h. p., placed one at each end. This power might be also used for the propulsion of the trains upon the pneumatic principle if desired.

The work of laying the tubes, it is estimated, might be expected to occupy five years, but if the seasons were moderate it might be done in three. (A full description of Mr. Bishop's system will be found in *Sci. Am. Supp.*, No. 20, May 13, 1876.)

A still more recent project for a subaqueous tunnel is to employ wrought-iron sections fastened from within. The details of this plan appeared in a recent number of *The Engineer*.

MODERN FIRE ENGINES.

V.

PUMPS (*Continued*).

[This series of illustrated articles was commenced in the February number of the REVEIW. In Nos. 1, 2 and 3, are described the Latta, Silsby, Merryweather, Clapp & Jones, Amoskeag, Dennison, Button, Gould, Shand & Mason, Roberts, and Jacket boilers. No. 4 gives the Silsby and Amoskeag pumps.]

The Clapp & Jones (horizontal) is perhaps the next most generally known piston-engine after the Amoskeag. The pump is of novel construction, and is so arranged that by taking off the heads (an easy operation) the valves can be taken out at the same time. The plunger has very great displacement. By introducing the water in the centre of the front head it is equally distributed through the annular pump-shell to all sides of the pump-cylinder and valve-chambers, making a very free water course to the valves. The pump is also "primed" at all times. Fig. 23 gives a side elevation, half in vertical section. Fig. 24 is an end view with upper half in transverse section through the centre of suction-valves (about ¼ way from the ends). *A* is the front head, with water-chamber connected to chamber *B* (also on suction side) by the annular space around the valve-chamber. *D* is the pump-plunger, of metal, water-packed. *a a a* are the induction-valves through which the water passes from chamber *B* to pump-cylinder. Fig. 23 shows the shape of these valves. *b b* is the discharge-valve, a ring of india rubber put on the inner end of the pump-head, but enough longer than the head to reach over the annular space and lap over on a ring on the cylinder which forms a part of the valve-seat, the water passing through the annular space into the discharge-chamber *c c*. This chamber extends all around the pump-cylinder. The discharge air-chamber and dicharge-gates are connected with it. The pump is one of surprising power and ease of action.

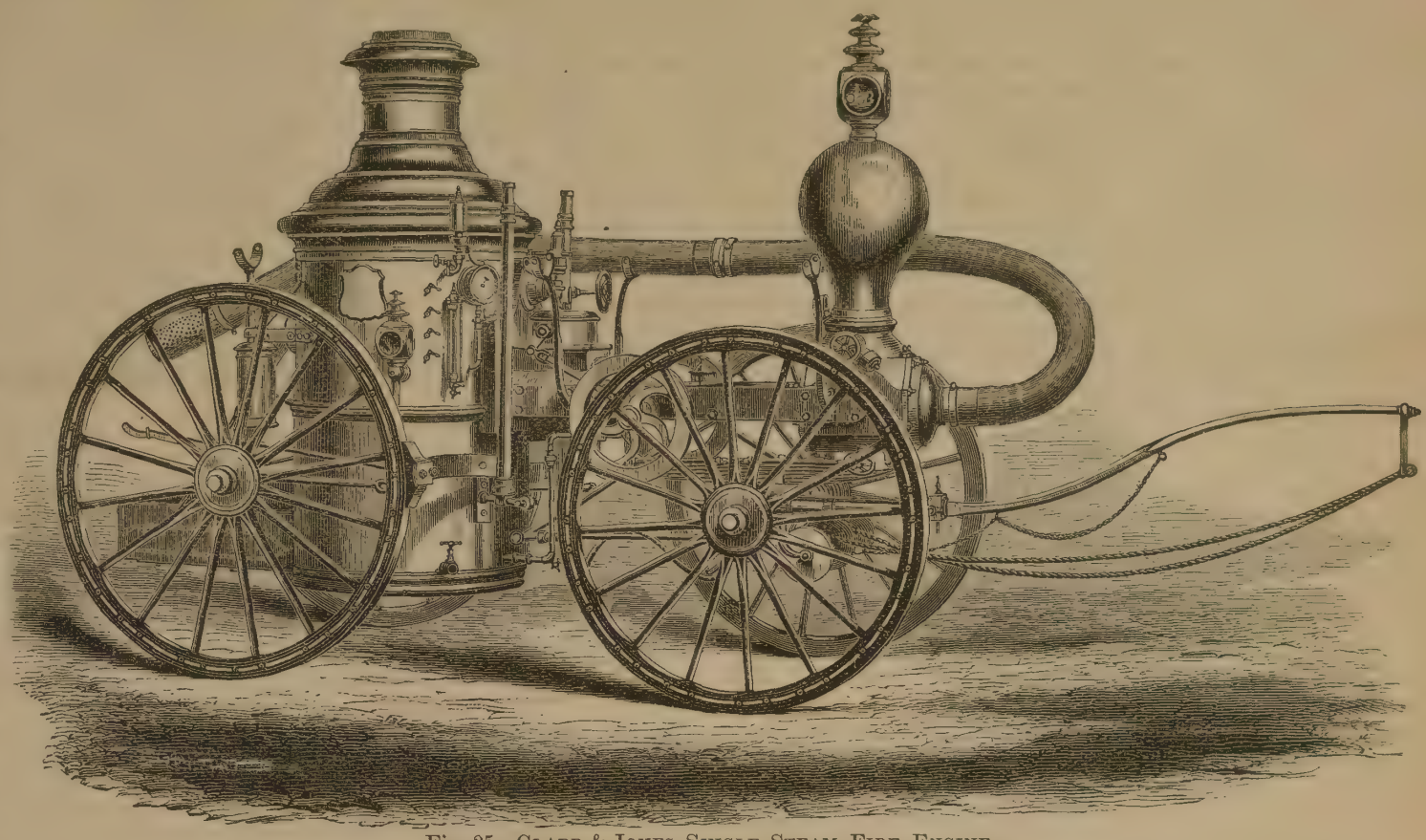


Fig. 25—CLAPP & JONES SINGLE STEAM FIRE ENGINE.

In the second-class Clapp & Jones machine there is one horizontal double-acting pump of bronze; diameter, 4⅝″; stroke, 8″; the piston travelling 100 to 300 feet per minute (1.66 to 5 feet per second). There is one large suction inlet in the centre of the forward pump-head. There are 20 rubber receiving-valves (central-hinged), with a united area of 60 square inches; and four rubber discharge-valves (ring-shaped), with a united area of 23 square inches. There are two outlets with 10 square inches united area. The suction air-chamber contains about ½ cubic foot, and is placed inside the discharge air-chamber, whose capacity is about 6 cubic feet. †

(*To be Continued.*)

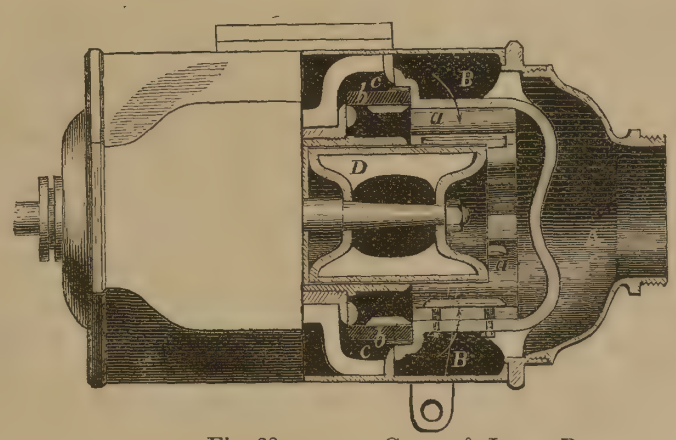


Fig. 23.

Fig. 24.

CLAPP & JONES PUMP.

EXTRACTION OF GOLD FROM AURIFEROUS ORES.

We condense from a lecture delivered recently by General T. J. Cram, of the U. S. Corps of Engineers, at the Wagner Free Institute, Philadelphia, the following points bearing upon this interesting topic.

I.—GOLD-BEARING MINES.

It would be beyond our limits to particularize the names or the precise localities of the numerous gold mines known to be in California, Colorado, Montana, Nevada, New Mexico, Old Mexico, Utah, Georgia, Virginia, North Carolina, New Hampshire, Canada, Australia, etc., etc. Neither is it practicable here to explain all the constituents of the ores in which the gold is contained, nor the operations of mining for obtaining these ores.

But attention will be more particularly called to the important question of profitableness or unprofitableness of extracting the gold from the ores after they have been mined and lifted to the surface of the ground.

II.—CHARACTER OF THE ORES IN FISSURE VEINS OR LODES.

These veins are the results of upheavals from the depths of the earth long ago. The upheaved belts or ridges containing them are not unfrequently miles in extent, and the ore crops out or comes near the surface of the ground in many places of the same ridge.

The ores are generally of rocky substance and confined measurably between walls of various inclinations to the horizon, and contain gold, silver, arsenic, antimony, tellurium, copper, iron, lead, and in most cases *much sulphur*. Every vein, however, does not contain all these metals, but most of them—especially those to which the lecture more particularly refers in respect to the process for extracting the gold—contain, with the gold, copper and iron in a combined state with sulphur.

When—ages ago—the upheavals occurred, the auriferous ore was mostly a sulphuret all the way from the bottom to the top of the vein, *i.e.*, the ore was left a sulphuret of copper or of iron, or of some base metal holding gold in the pyrites generally in minute particles.

Now, whether these gold particles were chemically or mechanically combined with the sulphur, we will not presume to discuss here. The opinion, however, is entertained by some prominent metallurgists, that the gold and sulphur were chemically combined, forming sulphide of gold. Suffice it to state the fact, however, that in these veins the fine particles of gold were tenaciously held in the sulphurets.

A vein thus charged having been shot upwards, as it were, nearly or quite to the surface of the ground, was left in a favorable position, more or less, for the upper portions of the vein ore to be acted upon by natural agencies.

The action of the atmosphere by its chemical agents, the rains, frosts and changes of temperature, during the long period since the upheaval, have produced a partial decomposition of the upper sulphurets, beginning at the top and extending downwards into the ore vein as far as these agencies could penetrate.

As a general rule this decomposition has reached down to the usual water level in the mine; and the effect has been to liberate more or less of the sulphur from the ore, and consequently a portion of the gold therein contained has become free, and easy to be extracted from the baser parts of the ore. Hence the origin and meaning of "Free Gold Ore."

The ore which has not undergone this decomposition, whether lying above or below the water level and yet tenaciously holding the gold particles, is denominated "Sulphuret Gold Ore."

As the shafts are sunk deeper in the veins, as a general rule, less of the former and more of the latter will be found in all fissure vein mines.

The "free gold ore" being nearer the surface of the ground costs comparatively less for mining and lifting, and from it, it is comparatively inexpensive to extract the gold. On the contrary, the "sulphuret gold ore," being deeper in the vein, costs more, and all processes hitherto used (until quite recently,) for realizing the gold from it, have been exceedingly defective, or so very expensive that many mines, in all countries, after having been profitable while the "free gold ore" lasted in them, have, on coming down upon the sulphuret ores, been abandoned, and the owners greatly discouraged: and this, too, after having raised great quantities of ore—which proved unprofitable to work—and hence have been neglected. Why is the opinion so prevalent that this

wasted ore is worthless? It is because there has been no method yet applied to it by which the gold could be extracted at a paying rate. From this cause there are many cases where engines, stamps, buildings and hoisting apparatus have been established, and shafts sunk and drifts extended into the sulphuret gold veins, and thousands of tons of ore raised and dumped upon the surface, all at a great expense, and all now lying idle and waiting for a process by which all may be utilized at a cheap rate of reduction.

In the United States, the auriferous veins, as far as they have been worked down, generally contain ores averaging 35 to 40 dollars per ton in gold; and the sulphurets exceed vastly in quantity the free gold ores; and while there are large amounts of the latter yet to be worked, the amounts of the former are simply enormous, and are only waiting for an application of a cheap and certain process for saving from them the gold, silver and copper they are well known to contain.

For our Western mines, the methods in general use cost on an average, for the ore, its transportation, and the extraction, about $40 per ton of the raw ore before the gold is realized. What margin of profit is therefore left to the mines in general when the average assay is only 35 to 40 dollars per ton? What hope is there for those many mines whose free gold ore has been worked out, and whose remaining sulphurets assay from $40 down to $10 per ton.

For convenient formulæ for judging of the profitableness or unprofitableness of working the ore from any mine, the following self-evident rules are useful.

1. When the cost of the ore delivered at the reduction mill, *plus* the cost of extraction, *falls below* the amount of gold *saved* per ton of ore by the process, the working will be profitable.

2. When the cost of the ore delivered, plus the cost of extraction, *exceeds* the amount of gold saved per ton of the ore, the working will be unprofitable.

These formulæ are applicable to any case, whether the ore be raised, shipped to Swansea and there reduced, or reduced by a mill at the mine, or distant from it.

From these it will be seen, all other things being equal, that in proportion to the *cheapness* of the process of extraction, the profit of working will be enhanced.

Again, it is seen from the formulæ, that the process which saves the *greatest amount* of the gold in the ore with the *least expense* of extraction, will be the most profitable that can be used.

By the ordinary process, heretofore working on a large scale, only about 25 per cent. of the gold in the ore has been saved; the remaining 75 per cent. having been lost. Some of the chemical processes, however, have saved considerably more than 25 per cent., but the cost of chemicals, and of the skilled labor required, have put the expense of extraction to so high a figure as to render them very unprofitable.

For example: By one of the most common processes in use, 104,062 tons of workable ore, costing $3 per ton delivered at the mill, and costing $13.64 per ton for extraction, yielded to the process $5,000,000, and there was lost by the imperfections incident to the process from the same ore, the sum of $15,600,000!

The inability, by the process used, to subdue the sulphurets, and the non-prevention in the extraction of the free gold of attenuated particles escaping before amalgamating, and the *flowering* and consequent loss of quicksilver carrying off the gold particles, are the chief causes of the enormous loss.

Recognizing the loss from the defects of the processes, more especially as applied to "sulphuret gold ores," metallurgists and chemists have exerted ingenious efforts in search of methods cheap in application, at the same time of capacity to save a large percentage of the gold in these refractory ores.

Of all who have entered the arena for this purpose, Mr. A. B. Crosby, after years of patient study, labor, and a large expenditure in money, regulated by a highly scientific and practical mind, seems to have been the most successful in solving the problem of extracting gold from the sulphuret ores to a very large per cent., at a cost cheap enough and upon a scale large enough to meet the demands of the "sulphuret gold ore" mines of all countries.

III.—DESCRIPTION OF THE PROCESS.

It is impossible in a paper so brief as this must be, to explain by drawing, the Crosby Mill. Suffice it to say, therefore, as follows:

Either stamps or a crushing machine with pulverizing rollers may be used to reduce the raw ore to small-sized particles, which immediately pass into "Crosby's Patent Roaster"—a heated iron cylinder, of nice and peculiar construction, revolving in a horizontal position on friction rollers, carrying the ore around in it—the ore thus becomes roasted, completely desulphurized in 15 or 20 minutes from the time it enters to the time of discharge from the roaster. On its discharge the roasted ore passes through a cooling apparatus, and thence into a burr mill, where it is ground to powder. The ground ore is elevated into a leaching tub and water admitted, and the leaching continued until the copper in the form of sulphate is all dissolved; which solution is then drawn off into a separate tank, in which the copper is precipitated by iron and saved, if there be sufficient in the ore worth saving.

After separating the copper, the pulp containing the gold remaining in the leaching tub, is passed into "Crosby's Patent Amalgamator," which is a conic frustum wooden tank of peculiar inside construction, holding from 3 to 4 tons, into which the mercury is let, and the mass is stirred from six to eighteen hours by the arms of a stirrer, being whirled by a belt and pulley. Here the amalgamation takes place in a *confined condition.* The number of hours stirring to complete the amalgamation depends upon the character of the substance surrounding the gold particles. After sufficient stirring, this mass is diluted with water to the brim of the tank, and after six hours drawing off, the amalgam of gold, holding with it the silver, if any be in the ore, is found in the close strainer box at the bottom of the amalgamator, and the free mercury which is left is forced, by a most ingenious contrivance, back without loss into a reservoir, ready to unite with the next batch of ore paste which comes into the amalgamator tank.

The amalgam is taken from the strainer box, to be retorted in the usual way.

In this process neither the attenuated particles of gold nor the mercury can escape during the amalgamation.

A mill, to treat twenty tons of ore per day, requires three roasters, four burr mills, four leaching tubs, four amalgamators, and ten employees—mostly common hands—with very few skilled persons among them.

The operations are almost wholly automatic, being moved by a sixty-horse engine, the power being transmitted by shaft, pulleys and belts, from the crushing of the raw ore to the amalgamation inclusive.

No chemical agents, except the sulphur naturally in the ore, oxygen of the air, heat evolved from the burning sulphur and from the fuel in the furnace under the roaster, together with pure water and mercury, enter into the process.

To a clear mind versed in chemistry, the chemical rationale of the process will be apparent on a mere reading of the foregoing meagre description. To the unscientific mind, intent merely upon getting the gold, the chemical actions attending the process are of no consequence.

In a report of Mr. Raymond, published by authority of Congress (in 1870), an allusion is made to the effect that this process had been tried and found wanting. At that time Mr. Crosby had only perfected his patent Roaster, with which he had succeeded in desulphurizing; but the amalgamating part was the defective element. Since then he has brought his patent Amalgamator to perfection, so that the criticism in Raymond's Report is no longer applicable to this process.

(*To be continued.*)

FIRE PROTECTION.

CONCERNING SPONTANEOUS COMBUSTION.*

I.

The process of combustion, from the astonishing variety of phenomena which it presents, its incalculable value in ministering to the wants and luxuries of man, and perhaps, more than all, from its dreadful character as an agent of destruction, has in all times been invested with an unusual share of interest. From its possibilities are derived a myriad of devices of human ingenuity and economy. The preparation of food and of innumerable articles of necessity or luxury are largely dependent upon it, while manufacturing interests of the most varied character are forced, in the employment of steam, to confess unqualified subjection to its power. As a destructive agent, manifesting its energy in the awe-inspiring terrors of the volcano, or the woeful horrors of conflagration, it sets at defiance the puny devices of science, and awakens in the mind an awful realization of the absolute helplessness of man to cope with nature's giant powers when once they have been loosed from control.

While the mass of mankind has ever viewed the agency of fire from the utilitarian stand-point, the attention of philosophers has, from the earliest times, been directed to the problem of solving the mystery of its nature and origin. But singularly enough, although this most common-place phenomenon has been abundantly treated of and speculated upon, it is only within a comparatively modern period that its true character has been explained. The earliest philosophical systems that have been preserved to us include the notion of the elemental nature of fire. The famous system of Aristotle, who was for centuries the oracle of the schools, explicitly embodied this idea, which, as is now generally conceded, he borrowed from Egyptian sources; and for the limited collection of positive data then extant, his fire, air, earth and water, were sufficiently explanatory. As alchemy gradually developed into prominence, the Aristotelian philosophy, concerning the elements, suffered certain modifications, and by its differentiation the number of the elemental substances was increased, while the originals from which they had been evolved, in course of time were overshadowed and supplanted. During the culminating period of Alchemy, for example, we are taught that there exists a certain element termed sulphur, to the presence of which in divers substances, their alterability by fire is to be ascribed. As illustrative of the importance of the phenomenon of combustion from a scientific point of view, it is sufficient to state that the modern science of chemistry owes its origin to the proper comprehension of its nature.

The first exhaustive theory of the nature of combustion originated with Stahl, an eminent Swedish chemist of the last century. The striking difference between bodies susceptible of combustion, or burning, and those that do not manifest this phenomenon, led him to ascribe all the changes which bodies undergo by the action of fire, to essentially the same cause. His idea was that all combustible bodies contain a combustible principle, or principle of inflammability, which they possessed in common, and to this supposed principle he attached the name *phlogiston.* He adopted, too, the ancient notion that the process of combustion is a destructive one, and that, while burning, a something separates itself from the combustible—that this something appears to us as flame. Stahl assumed that the more readily and energetically a body was consumed, the more phlogiston it contained; that when combustible bodies were heated to a certain point, they began to yield up their phlogiston, and continued to burn so long as they had any phlogiston to give, when they were reduced to a condition of incombustibility. The burning process was, on this hypothesis, termed dephlogistication; its opposite, phlogistication. By bringing a burned (dephlogisticated) substance in proper relations to another containing an abundance of phlogiston, it could generally be induced to take up its proper or normal quantum of this hypothetical matter, and thus be returned again to the condition in which it was before burning; and it was therefore possible, with many substances, to repeat the processes of dephlogistication and phlogistication without limitation.

We need dwell no further upon this once celebrated theory than to remark the observations that led to its fall. According to its teachings, the combustion of a substance consisted in the separation of its phlogiston. The body, in its normal condition, was presumed to be composed of the ash (or calx) which remained behind after burn-

*[Under above title there will appear, in consecutive forms, a series of articles treating of the subject of spontaneous combustion in its scientific and practical bearings. Much of the material that will be presented therein, has appeared in the form of occasional contributions or detatched items by the author, in the pages of the *Journal of the Franklin Institute, the American Exchange and Review,* and other well-known journals. It is the author's purpose to collect these scattered data and to present them, with much fresh material that has since been gleaned, in the form of a connected article, which shall contain all the facts and influences of value that are at his command. The subject is one upon which there is much popular misapprehension, and one which the *fire insurance interest* is especially concerned in having thoroughly understood. The attention of this body is therefore specially invited to the above communication, and those which are to follow.—*Eds.*]

ing, and the phlogiston which separated with the phenomenon of flame. If phlogiston, therefore, was a material substance, the body must of necessity weigh less after combustion than before. It was discovered, however, that a gain in weight actually accompanied this phenomenon. For a time, nevertheless, the phlogistonists endeavored to accommodate this discovery, and render it compatible with their system, upon the ingenious hypothesis that phlogiston (the existence of which, by the way, had never been demonstrated by its isolation) was a substance endowed with so exalted an affinity for the moon and other celestial bodies, that instead of being possessed of weight, it was possessed of levity; and that, therefore, on being separated from its state of combination by combustion, it left the body after its departure really heavier than it had been before. The discovery of oxygen by Priestley and Scheele, independently of each other, which occurred shortly afterwards, and the constant accumulation of accurate knowledge concerning chemical operations by the extending employment of the balance, shortly rendered impotent the theory that once was all-sufficient. In spite, however, of its many erroneous features, the phlogiston theory did most excellent service. It was the earliest system to recognize the notion of the chemical entity, or element,* as we now understand it. It was the first to venture an explanation—a natural one, though imperfect—of the processes of combustion and decomposition; but greater than these, its pre-eminent merit was the freeing of chemistry from the vagaries of the alchemists, and the recognition of its true mission as an independent science.

The origin of modern chemistry dates from the latter portion of the eighteenth century, with the publication of the ever-memorable anti-phlogistic theory of Lavoisier. Its distinguishing characteristic made itself manifest at the outset in a totally different conception and explanation of the process of combustion—an explanation supported by, and substantiated with, the testimony of the balance, and which, from that time to the present, has been received with universal recognition. Briefly stated, the modern system is founded upon the demonstration that combustion is not a process of decomposition or destruction, but, on the contrary, a combination of the constituents of the burning body with another, and this other is generally oxygen, the active constituent of the atmosphere. In this connection, the singular fact is worthy of notice, that the man upon whose discovery the great achievements of modern chemistry have been built—reference is here made to Priestley and his discovery of oxygen—should have steadily refused to accept its first and most brilliant development. He died as he had lived, a devoted phlogistonist.

In the present state of our knowledge, combustion may be defined to be, in its widest sense, any process of chemical union that takes place with sufficient energy to be accompanied by the evolution of heat or light; but as the vast majority of such combinations, or burning processes, take place in the air, the meaning of the term is popularly confined to the latter alone; and as, aside from their universality, they at the same time present the attendant phenomena in their most varied forms, they may with propriety be accepted as typical representatives of the whole class of phenomena included in this category. The extremely varied manifestations which the process of combustion may originate, when taken in connection with established social and commercial regulations, render the consideration of the theme which heads this article, of some importance. To reach it in a manner that will afford a systematic knowledge of its relations will require yet a few preliminary remarks.

The degree of energy with which a substance unites with oxygen (to confine our examples to the typical case just stated) will depend essentially upon the nature of the substance in question. Nearly all substances not already in combination with it, can be induced to enter into such combination. With many substances, not already in combination, this process, when left wholly to the operation of natural causes, goes on very slowly—so slow, indeed, as to be imperceptible by the senses. This phase of the process is called slow combustion; in scientific parlance, eremacausis; and the evolution of heat during its progress is so gradual, that it is almost invariably impossible to take note of it. It is important, however, to remember that, whether the phenomenon of oxidation occupies for its completion a few moments or as many years, the total amount of heat developed is the same. Of this species of combustion, the decay of wood and the rusting of iron are typical examples. Where the combustion is somewhat more energetic, it becomes the source of a moderate amount of sensible heat. The respiration of animals, for example—a physiological function in which the oxygen of the air inhaled is absorbed by the blood, and carried by its circulation to all parts of the body, to combine with and thus burn out effete tissues—affords us an excellent illustration.

From this point, we pass to those combinations which take place with sufficient energy to be attended with the evolution of both light and heat. In such cases, the process is sufficiently active to raise the temperature to a very high degree, and the result is combustion with the appearance of fire; and where the combustible, or the products of combustion, are of gaseous nature, the phenomenon of flame is manifested. A combustible body, or one that (to hold to our representative case) is endowed with an affinity to unite with oxygen, demands, however, the existence of certain favoring conditions before it will so combine. Of these conditions, the most important is temperature; and most, if not all bodies require to be sensibly heated before combustion will take place. The amount of heating will depend: primarily, on the nature of the body; and incidentally, upon the purity of the oxygen. The last named qualification, however, we may leave altogether out of consideration, since we are premising our combustions to take place in the air, the constitution of which is practically uniform at all times and in all places.

With different substances, the amount of heating necessary to induce combustion is very different, some demanding little or none, whilst others require to be heated to a red, or even a white heat, before the chemical union is effected. We purpose to revert again to this fact, further on. The condition of aggregation of a substance, again, by which we mean to indicate not only its condition of comminution, but likewise its allotropic modifications, has also a no less decided influence in modifying the temperature of combustion. The most instructive illustration of these facts is presented in the case of the element carbon. In its most finely comminuted condition, as lampblack, it requires but little heat to take fire; in the condition of charcoal, more heat is necessary; in the form of the several varieties of coal, it needs a still higher temperature to fire—and the difficulty of inflaming it will generally bear a direct proportion to the amount of metamorphic action to which the original vegetable matter has been subjected—the least inflammable of all the coals being the anthracite. In the form of the diamond, its combining temperature is still higher; while in the form of graphite, or plumbago, it demands such intense heating that even a blast furnace temperature of 2,000° is insufficient to ignite it. When combustion of one set of particles has once commenced, the evolution of heat is generally so great as to bring the neighboring particles to the combining temperature, or far above it; for which reason, when combustion has once set in, the application of heat from external sources is unnecessary, and the process is self-supporting until either the body is entirely burned, or the supply of air is exhausted.

There is, however, another class of bodies which, though often reckoned in the same category with the simple combustibles, yet possesses properties that demand a special consideration. We refer to those that, under favorable conditions, give rise to the phenomenon of explosion. The identification of these with the simple combustibles is eminently erroneous, for certain of them are far from being combustible; and the phenomenon of explosion, so far from being a process of combination, may be, and often is, either wholly or in part, a dissociation of the elements of the exploding body. Explosive substances—and the distinction is of much importance in estimating the relations of the phenomenon to our theme—are of three kinds. The first comprises the most common, namely, those which contain, either in intimate mechanical mixture or chemically united, all the elements required to give rise to new combinations throughout its whole mass in one simultaneous combustion—the burning up of every particle occurring at practically the same instant of time. The second comprises a large number of substances which become explosive only upon being brought into intimate mechanical mixture with some other substance with which they will unite with energy, or with some compound containing a supply of this substance. The third kind comprises a peculiar class of compounds, in which the chemical affinities holding their constituent elements united, are so feeble that it requires but little coercion to overcome them. Such compounds are termed, in chemical parlance, unstable, and their explosion signifies simply the simultaneous falling apart of the feeble compound into its elements.

To the first class belong gun-cotton and nitro-glycerine, which contain oxygen enough in their constitution to convert all the carbon and hydrogen which enter into their composition into carbonic acid and water at one simultaneous combustion. Gunpowder owes its energy to the same cause. The nitre that enters into its composition contains almost half its weight of oxygen, which, when ignition is started, suddenly combines with the sulphur and carbon, the other two constituents of the mixture.

To the second class are to be reckoned such substances as the fire-damp of the coal mines, or the vapor of hydro-carbons, such as naphtha, gasoline, etc., which, though not explosive *per se*, acquire this property upon being mixed with the requisite volume of air.

To the third class belong certain compounds, such as the iodide or chloride of nitrogen, in which the chemical affinities holding the elements in combination, are so feeble that the slightest disturbing influence causes them to dissociate throughout their entire mass—the result being, in many cases, simply the return of the constituents to their elementary condition.

We have now presented a systematic classification of the several categories of bodies affording the process of combustion and explosion, and propose, in what follows, to consider some of the rarer phases of these phenomena, which at times are manifested, and which, though in most cases well understood or readily explainable where the facts of the occurrence are at hand, are nevertheless associated in public estimation with much mystery and no little misapprehension. *

(*To be continued.*)

* Kopp-Geschichte der Chemie.

BORING CURVED NOZZLES.

Engineering, May 5, page 376, gives cuts showing the mode of boring curved nozzles with boring-tools having straight outlines, and brought into notice by Mr. Edward Reynolds Sheffield. The tool is a simple wedge, having a thickness equal to the smallest diameter of the nozzle, and a *diagonal* at the base, equal to the largest diameter of the nozzle. These tools are readily sharpened. About two years ago, the writer, very much annoyed by the spraying of streams thrown at steam fire engine tests, made some very costly experiments as to nozzle curving and boring, and found out the device alluded to. There are now several hundred curved gun-metal nozzles thus bored, in use in American fire departments, where they drove out the much vaunted "ring" and "straight-taper" nozzles, and have never been excelled except by some *glass-lined* tips brought out still later. †

TO WRITE UPON GLASS.

M. Terguem has communicated to the *Societe industrielle du Nord*, of France, a process which permits of very permanent writing being done on glass with ordinary, or India-ink. For this purpose, the surface of the glass is gently heated over an alcohol lamp, or Bunsen gas-flame, until the vapor of water ceases to condense upon it, when it is to be coated with a varnish made after the following recipe. The materials are, 80 grammes of alcohol (90°), 4 grammes of mastic, and 8 grammes of sandarac. This mixture will be dissolved by heating it over the water-bath in a flask well stoppered and tied.

This varnish is very hard, and ought to be completely transparent; if the surface over which it is poured is cold, it becomes opaque. The glass surface coated in the manner described, may now receive any design or sketch drawn upon it with ordinary ink or india-ink. It is then covered with a film of any non-alcoholic varnish.

This procedure may be advantageously employed as a substitute for the labels commonly used on bottles in the laboratory and elsewhere, to draw or trace sketches on glass for magic-lantern projections, etc. [*Moniteur industriel belge.*]

The Polytechnic Review.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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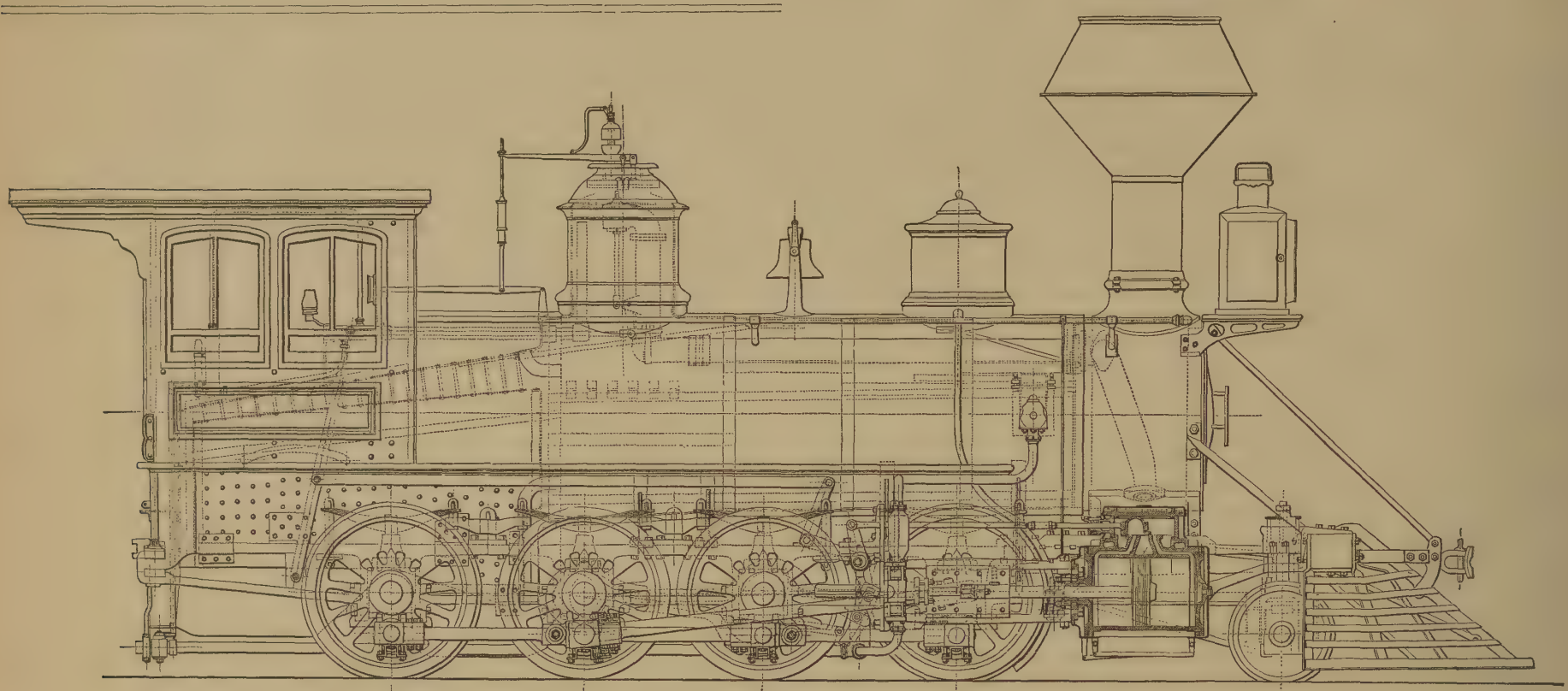
THE PURIFICATION OF ILLUMINATING GAS.

The Association of Engineers for Gas and Water Supply in Germay, offers through the Commission appointed at the fifteenth annual meeting, a prize of 1,500 marks (about $480) for a new method of removing, in a better and cheaper manner than heretofore, carbonic acid from illuminating gas, or for an improvement in the present method. The purification by lime does not fulfil all the requirements of practice. It is expensive, and the removal of the spent material is attended with serious annoyances; nor do other methods lately introduced, fully answer all requirements. The new method must be cheaper, more perfect, and capable of more general applications—and being designed to improve the candle-power of the gas, it must not act detrimentally on the light-giving constituents of the gas. The commission will test the methods in practice. The essays must not bear the inventor's name, but only a sign or motto; and must be sent in by the 31st of December, 1876, to Dr. Schelling, Chairman, Munich. [Abridged from *Am. Gas-light Journal*, xxiv, 200.]



From the Illustrated Catalogue of the International Exhibition 1876.

CENTENNIAL EXHIBIT OF BALDWIN LOCOMOTIVE WORKS.

I.

FREIGHT LOCOMOTIVE—"CONSOLIDATION PATTERN."

For the Pennsylvania Railroad Company. Constructed in accordance with drawings furnished by the Company. (Pennsylvania Railroad Company's "Class I.") Gauge, 4 ft. 9 inches. Fuel, Bituminous Coal.

LOCATION: SECTION E 6, COLUMNS 41-42, MACHINERY HALL.

CYLINDERS.

Diameter	1 ft.	8	inches.
Stroke of piston	2 ft.		
Length of steam-ports	1 ft.	5¼	"
Width of steam-ports		1¼	"
Width of exhaust-ports		2½	"
Travel of valve		5	"
Outside lap of valves		¾	"
Inside lap of valve		1/32	"

Exhaust nozzles—double, square.

WHEELS.

Diameter of driving-wheels	4 ft.	2	inches.
Diameter of truck-wheels	2 ft.	4	"
Distance between centres of front and rear driving-wheels	13 ft.	8	"
Total wheel-base of locomotive	21 ft.	6	"
Total wheel-base of locomotive and tender	47 ft.	7	"
Diameter of driving axle-journals		6½	"
Length of driving axle-journals		7½	"
Diameter of main crank-pin bearing		4½	"
Length of main crank-pin bearing		5	"

BOILER.

Outside diameter of smallest ring of boiler	4 ft.	6⅛	inches.
Thickness of boiler-plates (steel)		5/8	"
Number of tubes	138		
Length of tubes	12 ft.	11	"
Outside diameter of tubes		2½	"
Length of fire-box inside	8 ft.		
Width of fire-box inside	2 ft.	10½	"
Depth of fire-box inside (sloping)		42-61	"
Thickness of flue-sheet		½	"
Thickness of sides, back and crown-sheet		5/16	"
Square feet of grate surface	23		
Square feet of heating surface in fire-box	92		
Square feet of heating surface in tubes	1166		
Total square feet of heating surface	1258		

WEIGHT.

Weight of engine in working order	91,640 pounds.
Weight of engine on driving-wheels	79,400 "

MATERIALS.

Boiler, Bay State Iron Company's Homogeneous Cast Steel; *Fire-Box*, Singer, Nimick & Company's Homogeneous Cast Steel; *Tires*, Standard Steel Works' Crucible Cast Steel; *Truck-Wheels*, A. Whitney & Sons' Double-plate Chilled Wheels; *Flues*, Morris, Tasker & Co's Lap-welded Charcoal Iron Boiler-Tubes; *Injector*, William Sellers & Co.; *Steam-Gauge*, H. Belfield & Co.; *Headlight*, Pennsylvania Railroad Co.; *Brass and Copper Piping*, American Tube Works; *Jacket Iron*, W. D. Wood & Co's Patent Planished Sheet-Iron.

REMARKS.

The performace of engines of this class on the Pennsylvania Railroad is given in the following table, in comparison with that of the ten-wheeled engines also used for the freight traffic of the line.

NOTE.

CLASS.

I. Cylinder, 20 x 24; 8 driving-wheels; 50 in. diam.; weight on driving-wheels, 79,400 lbs.
E. " 18 x 22; 6 " " 50 " " " " " 56,000 lbs.
D. " 18 x 22; 6 " " 55 " " " " " 54,000 lbs.

Number of Loaded Cars and Total Weight of Train Hauled by Standard Class I, E, and D Locomotives over given grades on Pennsylvania Railroad, Philadelphia and Erie and Susquehanna Divisions, and Average Pounds of Coal per Car per Mile.

BETWEEN	Class of Engines.	EAST. 15 Miles per hour. Number of Loaded Cars.	EAST. Total Weight of Train, exclusive of Engine. Net Tons.	EAST. Maximum Grade.	WEST. 15 Miles per hour. Number of Loaded Cars.	WEST. Total Weight of Train, exclusive of Engine. Net Tons.	WEST. Maximum Grade.	Average Pounds of Coal per Car per Mile.	REMARKS.
Philada. & Columbia.	I.	35	735	40	30	630	49	4·2	I Engines haul 40 cars East 10 miles per hour
" "	E.	24	504	40	20	420	49	4.9	
" "	D.	22	462	40	18	378	49	5.2	
Columbia & Harrisb'g.	I.	70	1470		65	1365	17	2·7	Short grade of 30 ft. East and 37 ft. West.
" "	E.	55	1155		51	1071	17	3·2	
" "	D.	48	1008		45	945	17	3.4	
Erie & Langdon's.	I.	24	504	71					
" "	D.	15	315	71					
Renovo & Jersey Shore.	I.	80	1680						Grade of 26 ft. for 4 miles, remainder of run about level. I Engines very often haul this train at rate of 25 miles per hr.
" " "	D.	45	945						
Susquehanna Division.	I.	85	1785						
" "	D.	55	1155						

[*To be Continued*]

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

THE NICOLAIEFF FLOATING DEPOSITING DOCK.

This dock not only raises the vessels, but, when required, deposits them high and dry on fixed stages of open pile-work, for extended repairs; leaving the dock free for raising other vessels.

It is composed of a number of parallel pontoons of square or circular section, at fixed distances apart, and ranging transversely to the length of the dock. Each one is fastened at one end to a longitudinal structure forming the main side of the dock. The pontoons project from the side like the teeth of a comb. They are submerged when the dock is lowered for lifting a vessel.

The main dock side is never submerged, but is of sufficient depth to allow six or seven feet of free-board when the pontoons are sunk beneath the bottom of the vessel. When the dock is raised, the pontoon tops are well above water; the main side standing some feet higher than the deck of a raised vessel. The dock is L-shaped in end elevation, and would be unstable when submerged; hence it has an "outrigger"—a broad flat compartmented pontoon, loaded with concrete ballast until half submerged. Along its mid-line is a row of rigid upright columns projecting through the pontoon above and below, and stiffened by struts. To the top and bottom of each column is hinged a pair of parallel booms or bars, also hinged at their opposite ends to the dock sides, so that the outrigger remains stationary while the dock rises and falls. The side of the dock is, practically, a long box-girder, divided into numerous water-tight chambers. Its hight may vary from 20 to 50 feet, or more; its width from 10 to 15 feet; and its length is almost equal to that of the longest vessel to be docked.

The Nicolaieff dock has a side 280 feet long, 44½ feet high, and 12 feet wide. The pontoons are 72 feet long, 18 feet deep, and 15 feet broad; the clear space between them 5 feet.

The outrigger may be removed when the pontoons are not submerged. This leaves the dock much narrower than any other of the same capacity.

But the depositing feature is the main point of interest.

The staging consists of a number of piles, in parallel rows at right angles to the shore, and capped by horizontal timbers the same distance between centres as the pontoon spaces are; so that if the pontoon width is 10 feet, the clear space between the piles is 12 feet. The hight of the vessel above the water is greater than that of the staging. The pontoons bearing the vessel are inserted between the pile-spaces, and the dock being lowered a trifle, the ship is brought on to the staging and freed from the dock, which latter is then withdrawn.

The Nicolaieff dock is adapted for both circular and ordinary iron-clads. It is in three sections: two of 100 feet length each, and one 80 feet long.

Any one of these may dock the other. With the three end to end, the dock would raise and deposit iron-clads of ordinary form; with the sections arranged, as by Admiral Popoff's design, in a two-sided dock, it will receive circular iron-clads (or "Popoffkas") up to 140 feet diameter. It will raise a vessel of 4000 tons in a little more than an hour.

This form of dock may readily be enlarged at any time; it may remain free for other work during extended repairs to vessels; or its hulls may be lengthened amid-ships, or may be built and launched. Vessels have on it, or on the staging, superior facility for examination, painting or drying, and repair; while fleets by it might be "laid up in ordinary" on staging, and put into the water at a few hours' notice. The cost is very moderate.—[Abridged from a paper read by Mr. Latimer Clark, C. E., before the Institute Naval Architects; and published in *Engineering* for April 21, page 312.]

Semolina Separator—A new device has a centrifugal spreader, from which the bran and semolina grains are discharged, falling upon a floor-plate with concentric divisions leading to concentric funnels.—[Abst. from *Sci. Am. Supp.*, No. 21, p. 327.]

Corn Sugar is now made at Davenport, Iowa, at the rate of 500 bushe's per day.

The Time Gun at Pernambuco is fired by an Abel fuse ignited by an electric spark, the circuit being closed by the hand of the Arsenal clock.

A New Steam Pavement Rammer has a portable boiler, a steam cylinder whose piston bears a rammer, and which cylinder slides upon a transverse guide.

Changing Position of Propellers.—A recent device shown in *Sci. Am. Supp.* No. 20, p. 314, mounts the propeller shaft in a shell or drum, by the revolution of which the shaft is raised or lowered, while still remaining parallel to the keel, and to the axis of the drum.

A New Beam Compass consists of a wooden radius-bar with a pin for a circle centre, and bearing a sliding cork pierced for a pencil.

Hard Paper.—The French employ chloride of zinc for rendering paper as hard as wood and as tough as leather.

160 *Ton Hydraulic Crane.*—*The Engineer* describes and illustrates a crane, by Sir Wm. Armstrong & Co., for lifting 100 ton guns. The platform revolves on a live-roller-frame, 43 feet diameter. At the rear of this there is a counterweight box carrying 350 tons, to counteract the weight and leverage of load and crane. The lifting is done by an inverted hydraulic press hung in gimballs; and the revolution is effected by a hydraulic rotary engine. The rake is 65 feet. The crane is for Spezzia.

A New Copper Float, described in the *Scientific American*, May 13, p. 310, is formed of two hemispheres spun together and the seam closed by *galvanic deposition of copper.*

Chinese Welding is a cementing by *fused metal.*

Submarine Railway.—Dr. La Combe proposes, for the crossing of the English Channel, a *béton* road-bed with three galvanized iron rails; a water-tight boat driven by compressed air and a propeller, and illuminated by the electric light.

The Baxter Steam Canal Boats, which were to reduce the cost of canal transportation and drive the horse boats from the business, are not running this year, their proprietors maintaining that rates are too low to pay expenses. The lowness of rates, however, has not prevented the horse boats from carrying enormous quantities of freight. [*Railroad Gazette*, viii, 256.]

Pneumatic Tubes in New York.—During the past week, a large force of men has been engaged on Broadway in putting down lines of pipe for telegraph wires, and in laying pneumatic tubes. These tubes, four in number, are laid parallel to each other, and near together in the bottom of a trench about three feet deep, and directly above them, one foot nearer the surface, are the iron pipes through which the telegraphic wires will be drawn. The former separate into pairs soon after leaving headquarters at the Union Telegraph Building (where a powerful duplex steam engine is stationed to exhaust or supply the atmospheric tubes), two pipes going down Maiden Lane and thence to the Corn Exchange. The other two will extend down Broadway and Wall Street, to the Stock Exchange. In a short time, entire sets of pipe and tubing will extend northerly through Broadway, connecting, in their progress, with various hotels and other prominent places, as far up as the Brunswick Hotel, taking in their course the Grand Central Depot. Each of the pipes for telegraphic purposes will contain from 50 to 100 wires, the number depending upon the necessities of business.

In operating the pneumatic tubes, the message is taken precisely as written, put bodily into the carrier, and shot through to the Central Office. The transmission is almost instantaneous. At the further extremity of the tube, there will be a small circular opening in the wall from which the message may be sucked by the pneumatic power applied at headquarters. The other tube, where the message is received, will simply curve toward the flooring, with a basket beneath to catch the missive in its flight. [Abr. from *Iron Age*, xvii, No. 22.]

The Suez Canal.—M. de Lesseps, who has lately returned to Paris from a lengthy visit to the Suez Canal, has presented to the French Academy the results of his observations concerning the filling up of the channel with sand, and the proper measures to be taken to maintain its depth. He affirms that Port Said is in no danger whatever of being filled up with sand, and that there is no need of prolonging the piers as proposed. That operation, he believes, might prove a source of danger, since one single pier there might influence the current in a marked degree. The dredging machine made for the company works regularly and well, and suffices to keep the channel clear. Moreover, it does not fill up as rapidly as supposed, for the work done last year is still free from sand, and two large ships (the Serapis, 5,110 tons burden, and an English frigate, drawing over 20 feet of water) have recently passed through the canal without difficulty. M. de Lesseps also stated the important fact, that whereas formerly rain was unknown on the Red Sea, since the opening of the canal there are showers about once a fortnight, which in time will produce a decided and favorable influence on the vegetation and climate of the region. [Abridged from *Iron Age*, xvii, No. 23.]

TITLES OF IMPORTANT TECHNICAL PAPERS THAT HAVE LATELY APPEARED.

RECENT HYDRAULIC EXPERIMENTS. By Richard H. Buel. *E. & M. Journal*, May 13, page 467.

ON THE STRENGTH AND FRACTURE OF CAST IRON. By W. J. Millar, C. E. Read before the Institute of Engineers and Shipbuilders, in Scotland. In full, with discussion, in *Engineering*, May 5, page 373.

ON WATER TUBE BOILERS. By J. F. Flannery. Read before the Institution of Naval Architects. In full, with illustrations, in *Engineering*, April 21 and 28.

ON PUMPING AND VENTILATING ARRANGEMENTS. By Thos. Morley. Read before the Institution of Naval Architects. In full, with illustrations, in *Engineering*, April 21.

ON A NEW STEERING GEAR. By G. L. Watson. Read before the Inst. Nav. Arch. *The Engineer*, May 5, page 344.

ON THE PROPULSION OF BODIES THROUGH WATER. By Robert Griffiths. Read before Inst. Nav. Arch. *The Engineer*, May 5, page 344.

ON YACHT MEASUREMENT. By E. C. Sterling. Read before Inst. Nav. Arch. *The Engineer*, May 5, page 343.

MINING, METALLURGY AND MINERALOGY.

Statistics of Iron and Steel Production in the United States, in 1875.—From the just published annual report of the Secretary of the American Iron and Steel Association, we condense the following leading facts bearing upon these important industries. The system adopted by the Association in obtaining accurate returns has worked so well that the figures presented may be regarded as thoroughly reliable, the Secretary reporting that he has received returns from every rolling-mill except two, merchant mills, every furnace except five, and every steel works except one; and since the capacity and condition of these eight non-reporting establishments were well-known, the estimates of their production can vary but a trifle from the truth. The completeness of the numerous tabular statements exhibiting the different aspects of the subject in hand, is most creditable to the industry and intelligence of the Secretary, and we regret our inability, from want of space, to reproduce the report in full.

The production of pig-iron in 1875 was 2,266,581 net tons, against 2,689,413 tons in 1874, 2,868,278 tons in 1873, and 2,854,558 tons in 1872. The decrease in 1875, as compared with 1874, was 422,832 tons, or more than 15 per cent. The number of completed furnace stacks at the close of 1875 was 713 (not including abandoned stacks), as compared with 693 at the close of 1874, 657 in 1873, and 612 in 1872. Twenty new stacks were therefore added during the past year. Of these 713 stacks at the close of 1875, 293 were in blast, and 420 were out of blast.

The total production of all kinds of rolled iron in 1875, was 1,890,379 net tons, against 1,839,560 tons in 1874, 1,966,445 tons in 1873, and 1,941,992 tons in 1872. These figures embrace all kinds of rails, cut nails and spikes, bar, band, hoop, plate, sheet, angle, girder, beam, boat, guide, rod and bridge iron, and exclude all forged iron. Deducting nails and rails, the production of rolled iron in 1875, was 861,524 tons, against 864,538 tons in 1874.

The production of iron and steel rails of all sizes in 1875, was 792,513 net tons, against 729,413 tons in 1874, 890,077 tons in 1873, and 1,000,000 in 1872. Of the total rail production of 1875, 501,649 tons were iron rails, and 290,863 tons were Bessemer steel rails. In 1874, the production of iron rails was 584,469 tons, and of Bessemer rails, 144,944 tons. The production of steel rails was greatly increased,—from 6,739 tons in 1874, to 16,340 tons in 1875.

The production of Bessemer steel rails in 1875 exceeded that of 1874 by over 100 per cent. And the Secretary predicts that during the present year, this country will make more Bessemer steel rails than iron rails. There were ten completed Bessemer steel establishments in the country engaged in filling orders during the whole or part of the year. The production of Bessemer rails in this country since 1867, when the industry was inaugurated, has been as follows, by years in net tons:

1867	2,550	1872	94,070
1868	7,225	1873	129,015
1869	9,650	1874	144,944
1870	34,000	1875	290,863
1871	38,250		

21,145 tons of merchantable Bessemer steel other than rails were used for various purposes.

The aggregate production of steel other than Bessemer, at the forty-four establishments making cast, puddled, blister, and open hearth steel, in 1875, amounted to 61,058 net tons, against 49,681 ton in 1874.

The production of open hearth, or Siemens-Martin steel, amounted in 1872 to 3,000 net tons, in 1873 to 3,500 tons, in 1874 to 7,000, and in 1875, to 9,050. The country to-day has

an annual capacity of 50,000 tons of crucible cast-steel, and 40,000 tons of open-hearth steel.

The production of forges and bloomaries amounted in 1875 to 49,243 net tons, against 61,670 in 1874, and 62,564 in 1873.

The total value of our imports in iron and steel in the calender year 1875, was $15,273,315, against $24,600,720 in 1874, and $45,764,670 in 1873.

A New Mineral.—At a recent meeting of the French Academy, M. Bertrand described a new mineral from the Pyrenees, for which he proposed the name of Friedelite. It is a hydrated silicate of the protoxide of manganese. (*Nature*, xiv, 84).

The coal output of our country reaches 50,000,000 tons annually, and is doubling every ten years. [Andrew Roy, in *E. & M. Jour.*, p. 442.]

The American consumption of antimony is stated by the *Iron Age*, to be 3000 tons per year.

The Lancaster (Pa.) Nickel Mine is yielding 6,000 tons of ore per year. [*E. & M. Jour.*]

New Blasting Cartridges.—The *Engineering and Mining Journal* of May 20th, p. 488, describes General P. A. Oliver's improvements in cartridge manufacture. The cases are made by machinery; those for dry ground have the end rivetted with a copper or tinned rivet, and those for wet holes have the end formed of a double cup of tin, one setting into the other, and holding the paper of the cartridge between them. The cartridges are made of various lengths and are cheaper than hand-made.

Neglected Mines.—In connection with the abstract of Gen. Cram's interesting lecture on the extraction of gold from sulphuret ores, the following item, will not be without interest. The item is reproduced from the *Philadelphia Evening Telegraph*.

"THE GOLD OF NORTH CAROLINA AND GEORGIA.—We notice, with great satisfaction, the introduction of measures in Congress looking to the encouragement of the gold mines of the States above mentioned. These mines were extensively worked in former years. As early as 1830, the production of gold was so considerable, that private mining establishments were put up so as to literally coin the gold 'at the pit's mouth.' The name of Templeton Reid and Christopher Bechtler were familiar to the people of that region and of other portions of the United States. Mr. Bechtler's mint was at Rutherfordtown, North Carolina. In one of his statements, embracing a period of nine years, namely, from 1831 to 1840, it appears that he assayed and coined the sum of $2,241,840. The coins issued by Mr. Bechtler and Mr. Templeton (the latter in Georgia) were not imitations of the coin of the United States, but were of the nominal values of $10, $5, and $2.50. No devices upon them, but simply the weight, fineness, and value designated. Many millions of dollars of gold were at that time, and by the imperfect processes then known, produced and added to the wealth of the world.

"Subsequently the branch mints of the United States were established at Charlotte, N. C., and Dahlonega, Ga. In these institutions more than $12,000,000 were coined from 1838 to 1859. In 1861 they were discontinued. We give the above figures to show that the gold mines of that region have for many years been very productive.

"That interesting mineral region is well worth the fostering care of the Government to co-operate with the intelligent and enterprising men who are now engaged in further developments of its mineral wealth. An assay office at Charlotte would be of great value in stimulating the production of gold. Besides giving to the producers the facilities of casting into bars, and the exact ascertainment of their value, by the Government stamp upon them, it would make that point a centre of an extensive and highly-productive mining region, to which capital and enterprise would be greatly attracted."

The Natural Gas Lines for the Pittsburgh Mills.—It has been for some time known that, for some accountable reason, the flow and pressure of the gas in the conduit line of the Natural Gas Company, which supplies the mills of Messrs. Spang, Chalfant & Co., and Graff, Bennett & Co., at Pittsburgh, were not all that they should be. The gas as it left the well had a pressure in the neighborhood of 100 lbs., and at Spang, Chalfant & Co's Mill, 17 miles distant, it was rarely, if ever, 5 lbs. Such a large percentage of loss could not be reasonably accounted for by friction, nor were there leaks that could explain it. Quite an amount of speculation and theorizing were indulged in to account for the discrepancy, which were more or less satisfactory until the true explanation was reached. It has been discovered that, at the time the pipe was being laid, some one placed in it sections of pump logs, about eighteen inches long, which entirely filled up the pipe except the hole through the centre of the log, about two inches in diameter. A calculation shows that the conveying capacity of the pipe with these obstructions, was only about one-sixteenth of its actual capacity. The obstructions are now being removed. [Abr. from *Iron Age*, xvii, 22.]

Furnace Linings.—Mr. F. M. I. Cazin writes to the *E. & M. Journal*, May 20th, that he makes fire-bricks consisting *to two-thirds of their length*, of fire clay, etc., and the head one-third (eventually the side) of a layer of mixed plumbago, thus getting a pure plumbago fire-face, with about two ounces of plumbago to the square inch.

New Minerals.—Microcline, a new species of Triclinic Felspar with a Potassic Base.—M. des Cloizeaux.—The composition of this mineral is—

Silica	64.30
Alumina	19.70
Ferric oxide	0.74
Potash	15.60
Soda	0.48
Loss on ignition	0.35
	101.17

The specific gravity is 2.54.

Daubreite (Oxychloride of Bismuth), a New Mineral Species.—M. Domeyko.—This mineral is an earthy mass of a yellowish or greyish white, containing a great number of crystalline lamellæ, opaque, and of a nacreous lustre. Its hardness does not exceed 2 to 2.5, and its specific gravity is 6.4 to 6.5. Its composition is—

Sesquioxide of bismuth	72.60
Sesquichloride of bismuth	22.52
Water	3.84
Sesquichloride of iron	0.72
	99.68

Abstracts of papers read before the French Academy. [*Chemical News*, xxxiii, 201].

CHEMISTRY AND TECHNOLOGY.

New Researches on Gallium, by M. Lecoq de Boisbaudran.—I have just reduced to the metallic state about 10 centigrms. of gallium, which I believe is very sensibly pure. As I have stated, the first specimen of gallium presented to the Academy owed its solidity to the presence of a small quantity of foreign metals. Pure gallium melts at about 29·5°, and it therefore liquefied when held in the fingers; it remains very readily in super-fusion, which explains how a globule remained in the liquid state at temperatures falling at times as low as zero. Gallium obtained by the electrolysis of an ammoniacal solution identical with that prepared by means of a potassic solution. When once solidified the metal is hard and resistant, even at temperatures little below its melting point. Nevertheless, it is sectile, and possesses a cetain degree of malleability. Melted gallium adheres readily to glass, on which it forms a fine mirror, whiter than that produced by mercury. If heated to bright redness in presence of air, gallium is only oxidised very superficially, and is not volatilised. In the cold it is not sensibly attacked by nitric acid, but with the aid of heat it dissolves with the evolution of red fumes. The specific gravity of the metal, determined approximately on a specimen weighing 64 milligrms., is 4·7 at 15° C., with respect to water at the same temperature. The mean sp. gr. of aluminium and indium is 4·8 at 0°. The specific gravity agrees, therefore, with theoretical provision, but its extreme fusibility is a fact totally unexpected. For the other properties of gallium I must refer to my sealed packet, dated March 6, and to my former communications. With the permission of the Academy I will shortly describe certain new reactions of the compounds of gallium, and point out the method to be followed for its extraction from ores.

M. Wurtz laid before the Academy three specimens of gallium, one of them in a state of super-fusion, and demanded, in the name of M. Lecoq de Boisbaudran, that the sealed packet in question should be opened. This having been accordingly done by the Perpetual Secretary, it was found to contain the following paper:—

"The specimen of gallium which I had the honor of presenting to the Academy had been obtained by the electrolysis of an ammoniacal solution of sulphate of gallium. The metal thus prepared was solid, and even rather hard. The metal was gallium, containing, according to the indications of the spectrum, small quantities of zinc and insignificant traces of other metals.

"The solubility of oxide of gallium in ammonia not being great, I sought for some other solvent which might enable me to obtain concentrated solutions suitable for electrolysis. Caustic potassa dissolves a large quantity of oxide of gallium: this solution readily undergoes electrolysis, but the metal obtained by this process is liquid, and not solid like that obtained from ammoniacal solution.

"The following observations have been made on about 1 miligrm. of liquid gallium:—

(1.) A very small globule, exposed to the open air for more than three weeks, lost neither its liquidity nor its metallic lustre.

(2.) The metal is deposited upon a negative electrode of platinum as a dead, whitish grey coating formed of numerous minute globules. It dissolves in the cold in dilute hydrochloric acid with brisk disengagement of hydrogen.

(3.) The hydrochloric solution of the metal yields a fine spectrum of gallium; along with the zinc rays more feebly. The latter are less marked than with the solid gallium from the ammoniacal solution.

(4.) The residue from the limited evaporation of the hydrochloric solution of the liquid metal is neither colored by iodide of potassium, nor by ammonia, nor by hydrosulphate of ammonia. The dry residue from the evaporation was nevertheless sufficient to be distinctly visible. Mercury, therefore, is not present.

(5,) Liquid gallium, deposited by electrolysis upon a small piece of platinum, was heated to redness, or almost to redness. It adhered and doubtless became alloyed with platinum, and resisted the action of hydrochloric acid, but it was attacked by weak *aqua regia* along with a little of the platinum; the solution showed the rays of gallium. A slight whitish pellicle, insoluble in *aqua regia*, was detached from the platinum; this was, perhaps, oxide of gallium rendered insoluble by ignition.

"At the time of those experiments I still had a portion of the gallium which I had presented to the Academy, and which had been returned to me. I made use of it to satisfy myself anew of the hardness of this gallium, and of the nature of its spectrum, which I found as before was composed of brilliant gallium rays, feeble zinc rays, and insignificant traces of other metals.

"We cannot ascribe the liquidity of the gallium obtained by the electrolysis of a potassic solution to the presence of a small quantity of potassium reduced by the voltaic current, since the alkaline metal would have been quickly oxidised, both during the washings and by contact with moist air. I think, therefore, that pure gallium is really liquid, and if I obtained it at first in the solid state it was probably by reason of its being alloyed with small quantities of other metals, especially zinc. Solid gallium is, in fact, less pure than liquid gallium. The solidity of gallium seems to be caused by relatively inconsiderable quantities of foreign metals.

"We may still suppose that by the electrolysis of an ammoniacal solution there is deposited, not pure gallium, but a compound of the metal with the elements of ammonia—a hydride, amidide, or nitride.

"I eagerly await the time—I hope not far distant—when, having at my disposal several centigrms. of purified gallium, I shall be able to determine its physical properties, which promise to be interesting."—*Comptes Rendus.*

A Freezing Mixture.—After giving the proportions of nitrate of ammonium, in aqueous solution, suitable for the production of artificial ice, in several of the machines in use, the *Moniteur Industriel Belge* proposes the following mixture, which, it is affirmed, will produce a degree of refrigeration almost as considerable as the first named salt. This recipe consists in dissolving in water certain proportions of nitrate of ammonium, either with nitrate of sodium or potassium. For example, a mixture of 20 parts of nitrate of sodium with 80 parts of nitrate of ammonium, affords, by its solution in water, a reduction of temperature, amounting to 25 or 26° (C?). It is possible, of course, to vary the proportions of the two salts, so as to produce, within certain limits, any degree of temperature reduction that may be desired. [*Le Technologiste*, xxxvi, 319.]

Preservation of Paste with Salicylic Acid.—The souring and moulding of paste used by book-binders, and workmen in other trades, which according to circumstances occurs in about two or three days, may be entirely avoided, according to the statement of Herr P. Lang, by the addition and thorough mixture with the freshly prepared paste, of a few drops of salicylic acid. When thus treated, a paste may be kept for weeks in a heated room and without losing its freshness, and even when it has by long standing become dry and tough, may be at once rendered fluid and serviceable by treatment with hot water. The addition of the acid does not, according to this author, affect the stickiness of the paste to any sensible degree.

The above item will, doubtless, prove serviceable likewise to all who have only occasionally to make use of paste. [*Gewerbeblatt aus Württemberg.*]

Zinc as an Anti-Incrustator.—Messrs O. Bruckmann & Sons, of Heilbronn, in a recent communication to the *Württembergische Gewerbeblatt*, give most positive testimony regarding the efficiency of zinc as a preventive of the incrustation of steam boilers. They give the details of three trials of zing scrap laid in the boiler, all of which were attended with the most favorable results under circumstances where every other means failed. As a result of their experience, they recommend the use of one kilogramme (2·2 pounds) of zinc scrap per month per horse-power; a quantity that would vary somewhat according to the quality of the water.

The Employment of the Spectroscope in detecting the adulteration of aniline colors, and for the determination of shades of color for dying and printing, has been proposed by Dr. Reimann. The method which he approves, consists in throwing upon the image of the spectrum under examination, that of a photographed scale, by means of which the measurement and location of the absorption bands of the spectrum, and their designation by numbers, after the standard scales in common use, is rendered possible. [*Reimann's Färber-Zeitung*, 1876, 132.]

Removal of Indelible Ink marks from Woven Fabrics.—Chloride of copper completely removes, even from colored woven tissues, stains occasioned by nitrate of silver. The fabric is to be afterwards washed with hyposulphite of soda solution, and then thoroughly washed with water. From white cotton and linen goods, are still more readily removed by application of dilute solutions of permanganate of potassa and hydrochloric acid, followed by washing with hyposulphite of soda, and a good rinsing with water. [*Druggist and Chemist.*]

Artificial Orchil.—Orcein, the tinctorial principle of orchil, is now affirmed to be artificially produced from one of the constituents of coal-tar. According to the French patent of Vogt & Henninger, toluol ($C_{14}H_8$) is converted into toluolo-bisulphuric acid. It is then treated with lime, and again with an excess of soda at 300°, either with or without pressure. The melted mass in dissolved in water, saturated with hydrochloric acid, the solution concentrated, and the chloride of sodium removed by crystallization. The mother-liquid contains orcin ($C_{14}H_8O_4$), which on treatment with ammonia is readily converted into orcein. [*Reimann's Färber Zeitung, No.* 14, 1876, *Chem. News*, xxxiii, 211.]

Concerning Tempered Glass—As was to be expected, upon the announcement of the ingenious process of hardening glass, devised by de la Bastie, a number of modified processes have been proposed by inventors anxious to divide with the original inventor the credit (and incidentally the profits) of the new manufacture. Of these rival processes, that of Pieper, who has disposed of his invention to the German glass manufacturers for 300,000 marks, is the most prominent.

Pieper's process, according to a description of Hasslacher, consists in submitting the glass to be tempered, while at a red heat, to the action of a bath of superheated steam, and is thus distinguished from the method of de la Bastie, who, it will be remembered, treats his glass by immersion at red heat into a bath of hot oil, or paraffin.

Should the method of Pieper prove to be successful in practice, a question, by the way, that is somewhat doubtful, it will possess one substantial advantage over the process of de la Bastie, namely, that the use of the steam avoids the danger of the ignition of the tempering bath. To avoid the ignition of the hot oil, paraffin, etc., when the red or white hot glass was immersed in it, de la Bastie was obliged to devise special preventive mechanism, which to some extent added to the complication of the method. Pieper's process obviates this difficulty, and should the steam treatment be found to temper the glass with the same rapidity and completeness, the Pieper method will possess a decided advantage over that of de la Bastie, and will deserve the title of a substantial improvement.

Bastie has to deal with yet another rival, Herr Meusel of Thüringen, who has modified the former's process by plunging the glass directly on the tube on which it has been blown, into the tempering liquid. Bastie, it will be remembered, reheats the formed or finished glass objects again, to a red heat before tempering.

The Bastie method appears to be more rational than that of Meusel, and, according to Hasslacher's statement, yields far better and more certain results in practice, inasmuch as the glass about the pipe is already too much cooled down by the surrounding air to permit of tempering with success. As to Meusel's claims to originality in his invention (?) the reader may draw his own conclusions.

Almost simultaneously with Bastie, Mackintosh, in England, patented the method of submitting glass to the action of great cold, while lately Dr. Siemens, of Dresden, has patented a process involving the toughening of glass by subjecting it to pressure. Besides the above there are other less prominent inventors in the same field. Whatever may be the ultimate practical success of any of these methods, to Bastie belongs the credit of being the first to devise a practical process, and to give commercial importance to what is known as tempered glass.—[*Deutsche Allgemeine Polyt. Zeitung*, iv. 223 *et seq.*]

Iron Sheets Thinner than Paper.—The Pearson & Knowles Coal and Iron Co., (England) has rolled iron sheets .0015 inch thick, (or about one-third the thickness of ordinary newspaper) without their sticking together. [*Warrington Guardian.*]

Nutrient Flower Pots are largely made in Germany from cow-dung and earth. [*Hamburger Gartenzeitung.*]

Concerning Parchment Paper.—Herr Lüdicke gives the following as the results of his experiments on the increase of the tensile strength of paper parchmented by passing through sulphuric acid. The paper employed for these trials was made from cotton, and was passed from an endless band through a mixture of 9 to 9½ parts of English sulphuric acid (of 58 to 60° B.) to 1 part of water. The temperature of the liquid during the operation was not allowed to rise above 10° C. (50° Fahr.), and the duration of the operation averaged about three seconds. The acid appears to effect the transformation of the superficial layers of the cellulose into a substance analogous to starch (called hydrocellulose by Girard), which forms a species of cement, and unites the fibre of the paper more firmly. This process involves a shrinkage of the paper, amounting to from 5 to 10 per cent., and a loss of weight that is never under 10 per cent.

It was ascertained by actual experiment, that the acid treatment reduced the thickness of the paper from 34 to 37 per cent, while it increased its specific gravity from 32 to 42 per cent. The parchment paper was found, when submitted to tensile strain, to be with one sample 4.55 times stronger than the paper from which it had been prepared; with another, 3.44 times stronger; and with a third, 3.84 times stronger.

Trials with parchment paper that had been softened by a brief immersion in water, proved that it suffered a loss of strength amounting to at least three-fifths (3-5), as compared with its strength when dry. It appeared, finally, that the strength of the parchmented paper depends considerably upon the temperature of the acid bath in which it is prepared; and that a vegetable parchment prepared at a low temperature is stronger than one prepared at a high temperature. The regulation of the temperature is, however, very difficult, because of the heating of the acid-bath during the operation. [*Bayerisches Ind. u. Gewerbe-blatt.* 1876, p. 118.]

Influence of Frost on Colors.—Köchlin has made the observation that cotton goods died with indigo are decidedly decolorized by being allowed to freeze, and Göppelsröder alleges in virtue of certain experiments, that this effect is due to the ozone present in the air, which acts even at a temperature below 32° F., when the goods are wet. A number of other dyes are similarly affected under the same circumstances. [*Reimann's Färber Zeitung*, 1876, 114.]

What is Bad Water?—Prof. Frankland answers, that every liquid is unwholesome or polluted, which (1) contains in suspension more than 1-100,000ths of dry organic matter, or more than 3-100,000ths of dry mineral matter; or (2) contains in solution more than 2-100,000ths of organic carbon, or 3-100,000ths of organic nitrogen; or (3) which, when placed in a white porcelain vessel to the depth of one inch, shows under daylight a distinct color; or (4) which contains in solution more than 2-100,000ths of any metal except calcium, magnesium, potassium or sodium; or (5) which contains in suspension, solution, chemical combination, or otherwise, more than 1-200,000ths of metallic arsenic; or (6) which, after the addition of sulphuric acid, contains more than 1-100,000ths of per chlorine; or (7) which contains more than 1-100,000ths of sulphur in the state of sulphuretted hydrogen or a soluble sulphuret; (8) which has an acidity superior to that produced by adding two parts of hydrochloric acid to 1000 of distilled water; or (9) which has an alkalinity greater than that produced by adding one part of caustic soda to 1,000 of distilled water; (10) which has on its surface a film of petroleum or hydrocarbon, or contains in suspension more than 1-200,000ths of such oils.

Gallium melts at 85.1° F., so that it liquefies while held in the hand, and is more fusible than tallow, which melts at 92° F.

New (?) System of Illumination by Reflection.—Les Mondes illustrates Balestrieri's photothermic hollow sphere collector:—concentric reflecting segments of cones replace the Fresnel lenses. The *Scientific American* states that substantially this same device was patented in the United States, in 1871, by Lee & Baldwin, and described in that paper at that time.

A New Adulterant for Sugar is found; being finely ground *slag*. Réunion Island is the home of the fraud.

New Electrical Discoveries.—Prof. John Trowbridge, of Harvard has made a new induction instrument, in which the fine wire of the coil is distributed upon *two* straight electro-magnets; the cores are bundles of fine wires; the armatures are thin, soft-iron plates. The strength of the electric spark is increased 400 per cent.; its length, 100 per cent.

Suffocation Alarm.—Ansel proposes an alarm apparatus to detect the escape of street gas in a room.

A pear-shaped vessel, covered with a porous membrane or unglazed earthenware plate, has attatched to it a U tube filled with mercury. One pole of a battery dips into the mercury; the other terminates just above the mercury, in the open end of the tube. When placed in a room where coal gas is escaping, the gas enters through the porous plate faster than the air can escape; the mercury rises, the alarm is given. [Condensed from *Sci. Am.* June 3, p. 356.]

A Remarkable Eruption on the Hudson River Railroad, near Dutchess Junction, N. Y., hurled a portion of a large plateau into the cove beneath, leaving a crater 200x150 feet; four hours later another slide took place, accompanied by an explosion; and in the night there was another upheaval, with a torrent of water. The phenomena was due to the accumulation of water pressure in the sandy land.

Japanese Steel.—The Japanese swords are tempered eleven times; knives, four times.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—195th meeting, April 27.

Prof. William Robinson read a paper on his system of

WIRELESS ELECTRIC RAILWAY SIGNALLING,

illustrated by a working model.

The idea of using the rails as conductors for electric signalling seems to have been suggested in an English patent of 1848. In 1853, Dugmore and Millward received an English patent for communication between trains on the same line, and between trains and stations. But this system was impractical in requiring the insulation of the opposite wheels of all the carriages from each other, to *prevent* electric connection between the opposite rail lines, through the wheels and axles.

In Ball's English patent, 1860, *short* rail sections are used (20 ft., more or less) and are the terminals of line wires connecting with the station battery and magnet. The station signal is visual; being an indicator worked by wheels controlled by the electro-magnet. This is open to the objections of all "wire-systems"—of not indicating danger when a train breaks up or enters from a siding, and of showing false signals when the circuits, or signal-mechanism, or battery are deranged from any cause.

Of "long-rail" systems, the first U. S. patent was to F. L. Pope, 1872; apparently the same as that of Barnes & Hancock, in England, 1868.

The two battery-poles are connected with the two rails, their junction being effected only when the wheels of a car, united by their axles, pass over two rails; so that at all times, except when a car is on the rail-line, the circuit is broken; but as long as a car remains on them, the battery will work. Between one wire uniting a rail and the battery, is a magnet, which, when the circuit is complete, acts upon a lever connected with a rod leading to a signal on a post. When engine or car completes the circuit and places the battery in action, the danger signal is shown; when the circuit is *not* thus completed, a weighted lever throws the signal to clear or to caution as desired.

The objection to this system is that in wet weather, the ties and earth complete the circuit without the presence of a train.

In Mr. Robinson's system a new principle is involved. The rail section may be one or several miles in length; at one end the battery is placed, one pole attached to each rail; while at the opposite end is the magnet, one electrode to each rail. Thus a constant metallic long circuit is established through the rails and the magnet. When a train enters the section from either end, or from a siding, it "short-circuits" the current, because its wheels and axles are better conductors than the small wire of the magnet. The magnet being thus de-magnetized, releases its armature, throwing the signal to "danger," where it remains while the train, or a car, is on the section. On double-track roads no line-wires are used.

The inventor claims for his system superiority in the following respects: A spiral can be successfully operated through a long section of rails; it will show the pressure of a portion of the train on the signal-section when a part of the train, having broken loose, has passed beyond the section. (Breaking of trains is one of the most fruitful collision sources.) It will show the danger signal when a train has entered within a section from a side track or from the opposite end from that usually entered upon. A broken or torn-up rail will show the danger-signal. Any tampering with, or derangement of mechanism or battery, shows the danger-signal.

In a patent of F. L. Pope, Oct. 7, 1873, the magnet and battery at one section end, are connected together, and the terminals connected to the opposite rails of the section; while at the other section-end, precisely the same arrangement is made. Similar battery poles are connected to the same rails, whereby the batteries are opposed to and neutralize each other, keeping the magnets demagnetized, until a train, entering the section, short-circuits, and thus vitalizes the batteries and magnetizes the magnet.

Mr. Robinson sums up as follows:

"There can be no perfect system of automatic signalling which does not involve long sections of rails as principal conductors. It is impossible to use long sections of rails for the purpose, on the principle of opening and closing circuit, as the uniform and repeated failures of twenty years have proven. The only known principle on which long sections of rails can

be successfully used for signal purposes is that actually involving a constant circuit, by which is understood 'a circuit whose magnets are operated or controlled without actually opening the circuit through said magnets.'"

Mr. Robinson then made a communication upon prolonging the duration of batteries. A single Callaud cell would operate a long-rail section continuously for ten or twelve days with diminishing current. By duplicating the battery so that only one cell at a time is in circuit, every passing train throwing one cell in and the other out, automatically, the result is that the cells last 140 to 160 days, with uniform current. Thus duplicating the battery and using it intermittently, multiplies its duration seven-fold, quite in contradiction to the usual statement, that a given quantity of zinc will produce a certain and invariable amount of electricity, no matter what the time of consumption.

Prof. R. offered this explanation:

When a battery current is passed through a jar of acidulated water, the hydrogen collects upon the zinc pole, and the oxygen upon the copper pole. If then the battery circuit be opened, and the wires from the jar connected, the circuit will be the reverse of the original battery current. This so-called polarizing current tends to partially neutralize the direct current. If the circuit be kept closed for a considerable time, the polarizing current becomes stronger, until it entirely neutralizes the effect of the direct current.

The same takes place in the battery itself. With closed circuit the water is decomposed; the hydrogen collects on the copper element in a thin film, and acts in two ways to deteriorate the battery: (1) mechanically, by protecting the copper plate; and (2) chemically, being electro-positive, (as is zinc) and thus neutralizing the battery action. Alternately the batteries keep the plates clean and prolong their battery duration.

"On a wireless signal, in West Somerville, the battery has been in operation already, without renewal, more than one hundred days, and the current to-day is as strong as it was three months ago. Furthermore, the signal operated by this battery has been running now above eleven weeks—since finished—including the worst and most stormy weather of the winter, but without a failure of any kind."

MINING LABORATORY OF THE INSTITUTE.

Prof. R. H. Richards read a paper on the "Mining Laboratory of the Institute," comparing its present with its former condition.—[Abridged from *Boston Evening Transcript*, May 5, page 6, column 3.]

AMERICAN INSTITUTE OF MINING ENGINEERS.—*Conversazione*, Philadelphia, May 11.

The principal topic was the manufacture of Bessemer steel in Belgium and in Sweden. Mons. J. Deby, (whose papers on Bessemer steel manufacture in Belgium, read before the Iron and Steel Institution of England, are so well known) gave an account of the works at Seraing. Mr. A. Brusewitz, of the Fargersta steel works in Sweden, and General Wilder also made extended remarks of interest.—[From full report by "N.," in *E. & M. Jour.*, May 20, page 492.]

CONVERSAZIONE, Philadelphia, May 18.—A number of geologists were present, and Prof. J. P. Lesley made a lengthy, though highly interesting, *resumé* of "what we do not know of the geology of Pennsylvania."

FRENCH ACADEMY OF SCIENCES—APRIL 1.

Displacement of Stellar Spectrum Lines.—Father Secchi finds glaring discrepancies in spectroscopic observations; and asserts that a line may appear instantly on one side or the other, according to the disposition of the spectroscope, unless the observer has an index sufficiently certain and accurate to recognize the illusion of which he is the victim.

Theory of Sun Spots.—Mons. Gaston Planté compares the appearance of electric perforations in filtering paper, with the "willow-leaf structure" of Nasmyth; traces the analogy still further by preparing globules of incandescent metal obtained by fusing large wires by powerful electric currents. Mons. Planté concludes (1) that the sun is a hollow electrified globe, filled with gas and vapors, and covered with a liquid envelope of molten incandescent matter; (2) that the tubercles come from the undulations of the liquefied envelope; (3) that the spots are produced by the eruption of masses of gas and electrified vapors from within; (4) that the *faculæ* are a brilliant phase in the evolution of gaseous matters; (5) that the protuberances are formed by the gases themselves bursting forth in an incandescent state upon the interior, and are naturally more luminous than those gases which form the atmosphere at the surface.

ERRATA.

Art. *The Solar Engine*, line 1, for Erricsson *read* Ericsson. Line 8, for 1886 *read* 1866.

Art. *Modern Fire Engines*, col. 2, line 3 from top, for Jacket *read* Jucket.

Art. *Purification of Illuminating Gas*, line 1, for Germay *read* Germany.

CENTENNIAL NOTES.

Fig. 1 represents an improved machine for mixing chemicals, fertilizers, &c., and exhibited by Messrs. Poole & Hunt, of Baltimore. With a suitable holding vessel, revolving horizontally around its support, is combined a rubbing or mixing apparatus, that turns about *its* support, and in the pan. There is a guiding device combined with the mixer or rubber, and which causes the rotation of the pan and mixer to move the mixed or rubbed material to the central opening in the pan, whence it drops out and is carried away by any suitable conveyor.

Underground Telegraph System.—The naked copper wires are drawn through glass tubes, which are firmly held in position in the iron pipe by paraffine wax. For lateral connections, as well as convenience in laying, traps are used, into which the pipe is screwed, the wires passing over non-conducting bridges, as shown in Fig. 2, thus allowing any wire to be taken out and replaced without interfering with the working of the others. The pipes are connected by a coupling, which, after being bolted together, is completely sealed; the traps being closed and sealed in like manner.

By this system there is claimed to be no crossing of wires, no difficulty from atmospheric changes, no cutting of wires in cases of riot, no imperilling of life and property by the breaking down of poles and wires by snow storms or fires (causing interruption of telegraphic communication); but a perfectly reliable telegraphic connection under all circumstances.

This system is in use at the Centennial Exhibition, connecting the Finance and Commissioners' Buildings, and a working model of it is on exhibition at Machinery Hall, class 566, location B. 3.20.

Beesley Bros. (Barrow-in-Furness, Eng.), show a simple, compact, and powerful shearing, punching, and angle-cropping machine, well adapted for boiler and ship-work. A powerful T lever has its fulcrum in the cross-bar; the upright receiving a rocking motion from an eccentric in its foot, and beneath the floor. One end of the T operates a shearing-knife below or an angle-cropper above, as desired; the other end bearing a punch. The bits are thrown in or out of gear by a simple latch. The shafting and gearing are beneath the floor; the lever and guides cased so that no machinery is visible. The gaps are deep, adapting it for use with large plates. A swing-jib may be stepped in the centre of the top, for handling plates. The machine cuts inch holes in inch plate; shears inch bars, eight inches in width; crops half-inch angle iron, four by four, and weighs but six tons. (Fig. 3.)

Mr. S. S. Jamison, Jr. (Section 9, No. 66, B), exhibits his "Steam Water Injector," which reaches the limit of simplicity in construction and operation. The steam-nozzle is central and stationary. It is claimed that the injector is always ready for work; is non-freezing; is free from obstructions; is a good heater; raise water 45 feet; works with from 6 to 100 lbs. of steam; throws a steady solid stream, and its jet may be made a good steam indicator. The injector is shown in Fig. 4, page 69.

The *Ryder* Reciprocal Grate Bars consist of a series of alternating movable and stationary bars. The movable bars are moved backward and forward several inches by a lever in front of the boiler, through the ash-pit door. The movable bars, resting on friction rollers, are raised slightly above the stationary bars, and all the bars have corrugated or V-toothed upper surfaces for friction. Fig. 5.

G. W. Coe's Vertical Drill Press and Screw Cutter (shown by E. F. Pryor, Dayton, O.), has a small level-wheel on the drill-shaft, driven by a larger level on the side crank-shaft, and which drives the flywheel-shaft by means of an intermediate sized bevel-wheel. Where heavier work is to be done, the crank-handle on flywheel is used, giving greater power. The machine has self-feed and vise, which are adjustable, and will work either with or without them. Fig. 6.

Adolph LeTellier's Filter, made at St. Gilles, near Brussels, has a raised bottom in which are inserted a number of removable vertical tubes, with perforated walls, and with handles at the top. These tubes are surrounded with flat felt filtering rings, through which the liquid must pass before escaping through the perforations in the tubes. The supply-pipe has a compression shut-off, actuated by a float and lever.

Hanrahan's Rock Drill-Bit is approximately of X form, two of the wings being beveled equally and having their cutting edges equally bevelled and in a diameter; the other two wings having their edges unequally beveled, and, while at right angles with the equally beveled wings, being set respectively to one and the other side of the bit centre. The inventor claims that he secures a main cutting edge to work on, at the same time making the bits of X form without contracting the steel or rendering the drill liable to break. The complicated machinery employed to rotate some rock drill-bits is dispensed with, and a perfectly round hole guaranteed.

Hawkesworth's Spark-arrester (Halifax, N. S.), consists of a series of inwardly pointing triangular plates, arranged spirally and at right angles to the axes of a conical or cylindrical pipe, so that the ascending current strikes a series of baffles which cause it to pursue a spiral course.

Sanderson & Proctor's Automatic Fire Extinguisher and Alarm (Huddersfield, Eng.), has a number of mercurial thermometers, with the wires of a galvanic circuit fused in the bulb, and in the stem at any desired point in the scale, or that the rising of the mercurial column to where it reaches the wire in the stem completes the circuit; attracts the armature of an electro-magnet, releases a detent, and by the fall of a heavy weight opens a poppet valve and causes the instant flooding of the room.

Hewett & Follansbee (Washington, D. C.), have saw-filing machines especially adapted for band-saws. The blade being gripped between guides, a semi-circularly-curved file of triangular section, mounted on the face of a wheel whose axis is parallel to the saw cuts or grinds the tooth. The remaining portion of the wheel's periphery is occupied by a "guide"—a metal blade with sufficient pitch to feed the saw forward one tooth during a half-revolution. Thus, continuous rotation of the wheel bearing the curved file and screw-guide files and feeds the saw with accuracy and rapidity. Teeth of any size, depth or angle may be filed. The "setter" has a similar feed, a trip-hammer with elastic flexible handle, and actuated by a cam, effecting the setting automatically.

W. Walker's Detaching Hook (Birmingham, Eng.) is for the prevention of over-winding in hoists of any kind. A pair of jaws working on a centre-pin, in such a manner that the weight of the load has a tendency to open the upper limbs, which clip the strong centre-pin of a shackle. The upper limbs are formed externally with jaw-hooks. The jaws are kept together, and made to retain the shackle-pin by means of a clamp held in position by pins.

In case of over-winding, the jaw-hooks (held together firmly by the clamp) pass freely into the ring; but the projections of the clamp coming into contact with the bottom flange of the ring hold the clamp stationary while the jaws are being pulled through; the result being that the pins are sheared off, and the jaw-hooks released from the restraint of the clamp. The internal diameter of the ring being the same as the width across the jaw-hooks, the rope remains secure until the jaw hooks reach the top of the ring; when, by the action of the weight of the load, they are forced open, and so hook on to the top of the supporting ring, the rope passing harmlessly over the pulley.

Carlisle's Safety-Lock for Elevators (Steubenville, O.), consists of a pair of clamping-jaws, which are actuated by the weight of the cage to seize the guides and arrest the downward movement of the carriage whenever the lift-rope slacks or breaks.

Chatfield, Underwood & Co., New York, show their "Angular" or "V" leather belt, having truncated pyramids of leather riveted to the inner or pulley surface of a flat leather band, and "gripping" in the angle of a V-shaped groove in the pulleys.

Adams' Patent Grate Bar, with diagonal cross-bars, claim uniform distribution of air-surface and immunity from warping.

Adams' Shaking Grate has bars with rack-teeth meshing.

Perkins' Super-heated Steam Oven for Ships is made of a double case of iron, with a space between filled with a non-conductor. It is heated by means of a series of wrought-iron tubes, each tube separate, partly filled with water, and *closed at both ends*. The tubes are inclined towards the furnace, to keep the water at the fire end; they are fixed in the oven, side by side, in parallel lines; one line under the oven floor, the other under the top inner surface of the oven. One end of each tube is projected into the fire-box, which is very narrow and extends across the case. As the water becomes heated it expands and fills the tube with steam of an equal temperature—450 lbs. pressure giving 456° F.

The Langen & Otto "Atmospheric" Gas Engine, in the German Section, attracts much attention from its lack of a crank, and from its peculiarity of preserving unchanged the velocity of rotation of the fly-wheel under all circumstances of light or heavy load.

The Department of Mechanical Engineering, Cornell University, makes an exhibit of the handiwork of its students, well worth noticing. We shall describe the Cornell exhibits in detail, at our earliest possible opportunity.

The Victor Hand Rock Drill has a drill-shaft raised by wipers on the crank-shaft; the force of the blows being given by springs. The rotation is effected by pins upon the lifting cams engaging projections upon the clutch surrounding the drill-bar. The bit has two curved cutting edges with their convex sides facing each other and at equal distance from the center. Location, Machinery Hall, A 55.*

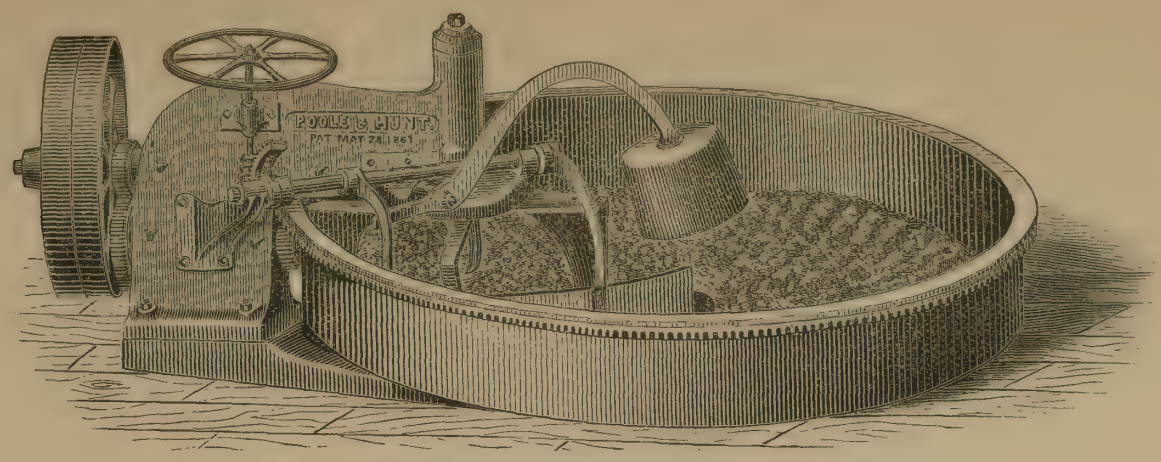


Fig. 1.—MACHINE FOR MIXING CHEMICALS, FERTILIZERS, ETC.

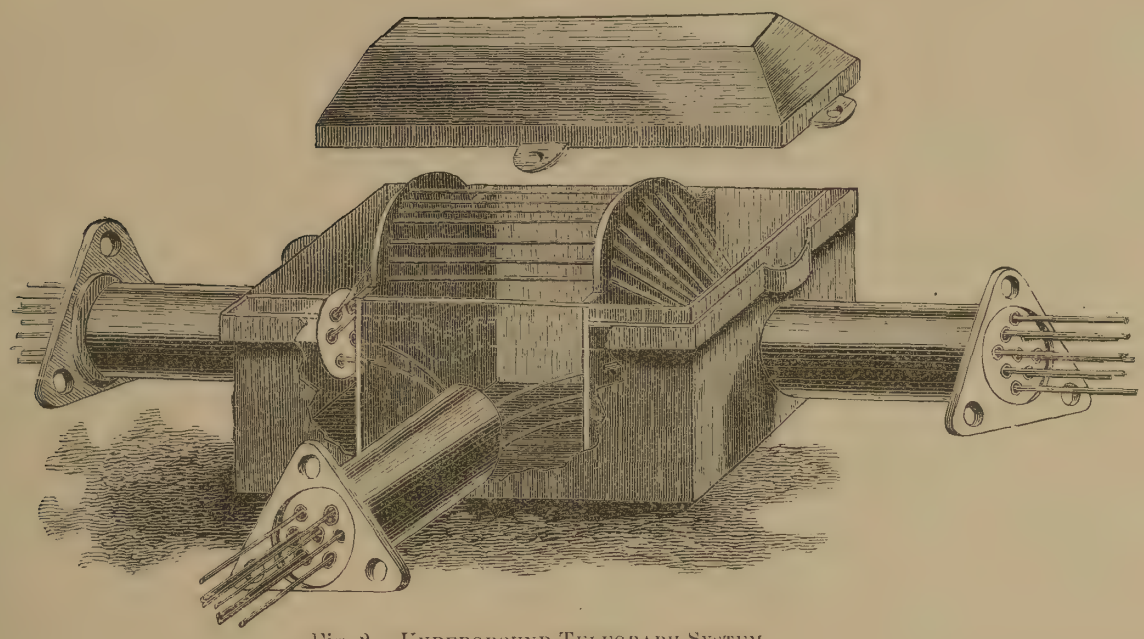


Fig. 2.—UNDERGROUND TELEGRAPH SYSTEM.

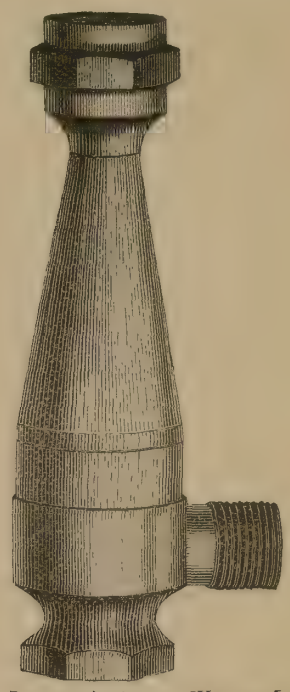


Fig. 4.—JAMISON'S STEAM WATER INJECTOR.

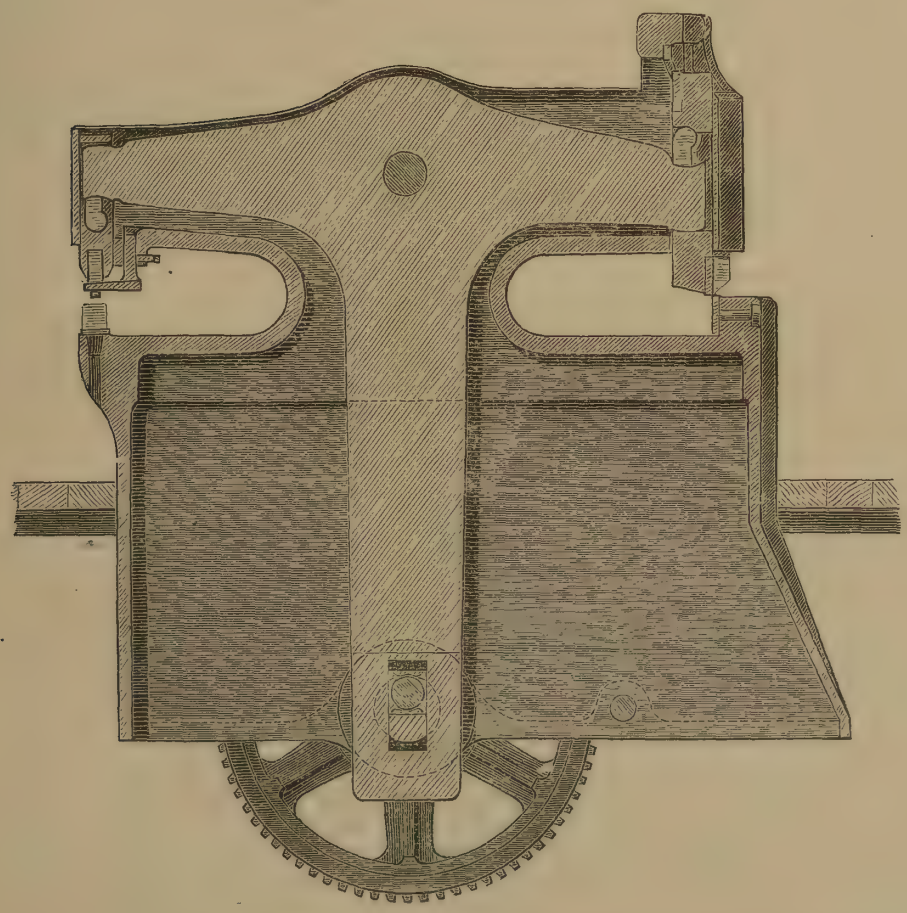


Fig. 3.—BEESLEY BROS. SHEARING, PUNCHING AND ANGLE-CROPPING MACHINE.

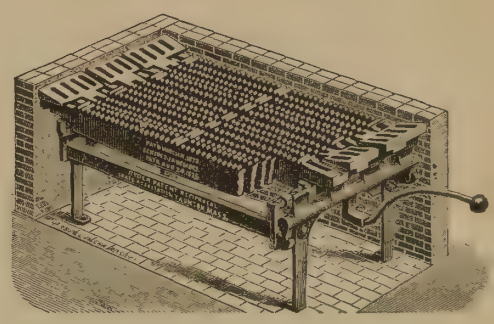


Fig. 5.—RYDER RECIPROCAL GRATE BARS.

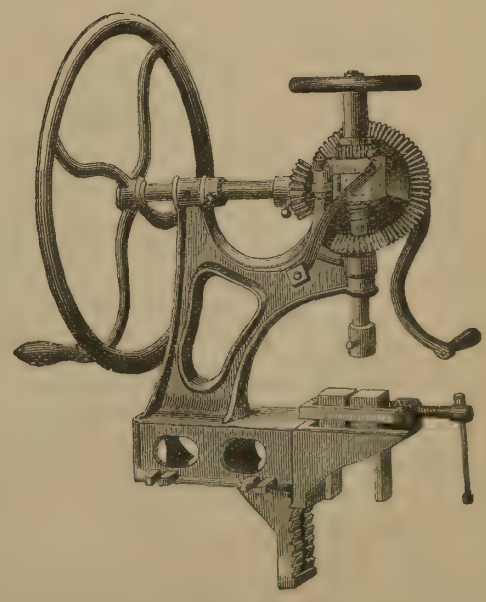


Fig. 6.—COE'S VERTICAL DRILL PRESS AND SCREW CUTTER.

A Car Truck Shifter, by R. H. Ramsey, Cobourg, Ontario, has a narrow and level double track on each side of an ordinary track, which has a pit or double incline deeper than the hight of a car-floor. On each side of the outside double track is a truck; a strong beam connecting the two trucks and crossing the middle track. The outside trucks are run back until the beam passes across and under the car-body. The car and outer trucks are then moved forward; the forward car truck descends the incline and the forward end of the car-body rests on the beam and outer trucks. When the forward car-truck is at the centre or bottom of the double incline, the car-body, although still level, is far above it. The truck may then be rolled away and a new one put in place; running the whole system on to level rails throws the car body on the new truck, and raises it off the beam and auxiliary trucks.

Albin Wurth's Cloth Cutting Machines are of two styles: "Standard" and Traveling. In both, the cutting is effected by a rapid vertical reciprocating motion of a chisel with slightly inclined edge. In the "Standard" machine, the cloth is moved against the knife or chisel; being assisted by a rotary feed-wheel. The "Traveling" machine has a horizontal guide bar along the back of the table; above this travels a round belt passing over a vertical pulley. The cutter is at the extremity of an arm, one end of which rolls on the longitudinal guide rod, the other being supported by a circular foot-plate. The motion is transmitted by a round belt driven by a pulley, which is rotated by the back main belt, already alluded to. The capacity of the Warth machine is stated to be from one thickness of fabric to $1\frac{1}{4}$" solid.

The Schlickeysen Brick Machine (German Section) is a clay "bar" machine; the bricks being cut two at a time from the bar, by a hand-worked frame with tightly stretched wires. The bricks made are very large; the narrow faces smooth; the corners rounded; the largest faces rough from the slow action of the wires. The bar has a section equal to the largest face of the brick.

The Bureau of Construction shows, in the Government Building, a pair of engines, 36"x48" cylinders, with moving parts of low-steel; the weight being but 42 T. for 800 H.P., or only 108 lbs. per H.P.—being the lightest engines of their power in the world. Designer, Chief W. W. W. Wood; builders, Wm. Wright & Co., Newburgh, N. Y.

Von Essen's Steam Boiler Flue Cleaner has a perforated steam-tube which is drawn up and down before the flue-sheet, without opening the smoke-box doors. Steam is blown through the flues in succession as the tube passes them. (In German Section).

The "Fenno" Cloth Cutter has a double-hinged horizontal arm, and a *rotary*-cutter, easily sharpened on an emery-wheel while running. It claims to cut up to 80 layers of cloth. It is quieter running than the "Warth" machine.

W. G. Von Staden, of Strathroy, Ontario, shows a model of a car-frame with vertical and roof timbers of bent wood.

A "*Meter Lamp Post*," shown by the American Meter Co., Philadelphia, has a small ordinary dry meter in the base, to which access is gained by a door in the side.

The Keystone Bridge Company exhibits in the Main Building (T 66, No. 4512, second door from east end,)

(1.) A model of Raritan Bay Swing Bridge, (N. Y. and Long Branch R. R.,) 1-24 full size.

(2.) Details of Steel Arches of the Illinois and St. Louis Bridge—the largest arched bridge in the world.

(3.) Weldless Eye-bars for Chords and Suspension Bars of bridges.

(4.) Rivetless Wrought Iron Columns, of the system peculiar to this Company.

(5.) Drawings of Ohio River Bridge, $4\frac{1}{2}$ by 21 feet, Cincinnati Southern R. W. Co., 520 feet, being the largest truss span in the world.

Photographs on exhibition show the great span of 350 feet, at Belair and Parkersburg, and the channel span of the Newport and Cincinnati Bridge, 420 feet; all designed by J. H. Linville, C. E., and constructed by the Keystone Bridge Company.

We hope to present the *chefs-d'œuvre* of this company in detail before our readers, at no very distant date.

MISCELLANEOUS.

MONSTER BELGIAN CORLISS ENGINE.

"A Constant Reader" writes to "*Engineering*," May 5, page 366, that the honor of possessing the most powerful Corliss Engine in the world, belongs to the flax and jute yarn spinning factory of the Société de la Lys, at Ghent.

These engines have cylinders 46" diam., 10 ft. stroke; revolutions, 32 per minute. Power.—the engines were built to develope with a given expansion and pressure, 2,000 indicated H.P. Spur fly-wheel 30 ft. diam., 32" face, of 10 segments; noiseless cut gearing, and weighing 108 tons. Shaft 21" in diam. in bearings, 23" in center; made at Krupp's Steel Works, in Essen. The consumption is stated to be but 0.800 kilog. = 1·763 lbs per indicated H.H.P.

Weather Reports.—There are now 108 stations in this country; the observers in which are regularly drilled soldiers, educated for this especial service at Fort Whipple, Va. Besides tri-daily reports from each station, the Bureau at Washington receives 383 daily reports from observers who were under instructions from the Smithsonian Institute for twenty-four years. In addition to these, again are 123 reports from the army medical corps, and 214 cable telegrams from almost every country in Europe, making a total of 1,044 daily reports received in Washington. From these are drawn and published nine daily charts, giving a view of the general meteoric condition, besides monthly and yearly charts, of which, the unparalleled service to science, the International Congress has just commended. From the aforesaid daily reports are drawn the forecasts of the weather, and of approaching storms, by which the service is best known. Forecasts intended for the especial benefit of farmers are issued, and the average time elapsing from the moment when the telegram leaves the Central office to its appearance as a printed bulletin in every post office where there is an agricultural population, from Maine to Florida, is only ten hours. In 1874 the number of farmers' bulletins issued was 6,'86, and the entire sowing and reaping of the country may be said to have been directed by them. In the same way transportation on our canals has been regulated by the especial forecasts, made for the benefit of shippers, of the freezing of canals. From the daily reports of the rise and fall of our great river highways, warnings have been given of every approaching flood, and in the Mississippi Valley alone, during the great floods of the last two years, a vast amount of property was saved by this means that could have been saved by no other. The most apparent benefit of this service, however, is in the cautionary signals displayed in the lake and sea coast harbors of approaching storms. Violent gales are thus foretold, and an incalculable amount of property saved, under circumstances where the warning could not possibly have been otherwise given.—*Manufacturer and Builder.*

The Latest Statistics give number of carpet-looms of all kinds in Philadelphia as 4000, and the average annual value of all goods produced is estimated at $19,000,000.—*The Carpet Trade.*

Perception of the Human Voice.—Deaf persons hear vowels more readily than consonants. Recent experiments found the sound of *a* to be heard 233 yards; *o*, 230 yards; *e*, 220 yards; *i*, 220 yards; *d*, 200 yards; *g*, 150 yards. It is to be regretted that the experimenters did not take the range of phonetic sounds.

The Fever-tree in France.—According to late accounts, the Australian fever-tree (*Eucalyptus globulus*) has taken kindly to the climate of France. Some three years ago, M. Cortambert planted 2000 seedlings a few inches high, over one hectare of land. The trees are now about thirty feet high, the stems having a circumference of about fourteen inches at three feet from the ground. Plantations of this tree are said to be numerous in the South of France (*Nature*). The experiment of its introduction into Italy is said not to have been successful. In this country, it has been introduced into California with the best results, and it is affirmed that not less than 1,000,000 trees of this description have been planted in that State.

On explanation of the above statements, it will be of interest to remark that the *Eucalyptus* is an evergreen, attaining a maximum height of three hundred feet, and thirty feet circumference, and as may be inferred from the outset of our item, an exceedingly rapid grower. It has dark, bluish leaves about one inch wide and ten inches long, thin and twisted, which enhale a camphor-like odor. The *Eucalyptus* tree possesses remarkable anti-febrile virtues, and in some countries has been systematically planted in fever districts as a sanitary agent. There are boundless forests of it in Australia, where it is indigenous, and grows both on the hillsides and the lowlands, in a range of temperature from 120° to 20° Fahr. As a timber, it is exceedingly useful where strength and durability are required, and though hard, is easily worked.

It is extensively used in Algeria for carriage building. About $4,000,000 worth of the wood are annually exported from Australia. Scientific bodies are giving great attention to it, both for its value in draining marshy grounds, and in disinfecting the atmosphere.

Ivory.—Great Britain imported 680 tons in 1875; the greatest amount since 1842, when it was 297 tons; her ivory imports in 1844, being but 211 tons. It is worth from $275 to $335 per cwt. for largest teeth. [*British Mail.*]

Muntz's Tannin Tester.—*The Engineer* illustrates a simple tannin-tester, in which a solution is forced by a screw through a piece of hide, and its density determined before and after this forced filtration.

The so-called "asphalt" and utterly abominable composition walks, are of the cheapest, nastiest, mushiest, and most perishable kind. That they should have been laid in Philadelphia after their disgusting failure elsewhere, is bad enough; but to smear such stuff upon the unprepared ground, for thousands of foreigners (accustomed to the hardest and smoothest of *trottoirs*) to walk over and sneer at as an example of what Americans can do, is both an outrage and an insult. Furthermore, such walks are a barefaced swindle; and would be a swindle at nine cents a square mile. Those who make such stuff and palm it off as good, honest asphalt pavement, should be treated to a coat of the mess, and then ridden on a "one-rail" road.

The Battle of the Pavements.—After a sufficient comparative trial, the contest between granite, asphalt and wood for carriage ways has been decided in favor of the last, and the recent conclusion of the Corporation of London may be regarded as a final confirmation of that decision. Mr. Heywood, engineer for the City, has shown that before a horse falls he may be expected to travel on granite 132 miles, on asphalt 191 miles and on wood 446 miles; and although between the two last materials there is a trifling advantage in cost on the side of asphalt, that is much more than counterbalanced in other ways. In easy traction and the absence of noise, there is no comparison between wood and granite, and since the surface water has been kept out by means of asphalt, wood has become one of the most durable of pavements. The rapidity with which it can be laid, and the ease with which it can be repaired, are not the least of its merits, while the flooring of planks, which is now laid as a superstructure, gives great elasticity, and by distributing the weight equally over the whole pavement, adds to its power of endurance. [Iron vii, 579.]

BIBLIOGRAPHICAL NOTICES.

ESSAY ON SCIENTIFIC PROPAGATION; BY JOHN HUMPHREY NOYES. Published by Oneida Community, Oneida, N. Y. 32 pp., 8vo, unbound.

This little book is ably and dispassionately written, and is well worthy of perusal. It advocates the study of stirpiculture and its practice, when some institution shall be devised which shall better and replace marriage. It calls for "breeding in and in;" for paying as much attention to blood as to training; shows the Jewish practice of interbreeding; concedes that marriage is the best thing for man as he is; remarks that "it is the glory of marriage that it utilizes the passions of men so as to provide homes for women and children;" criticises the Catholic Church in that it "discriminates" directly, and outrageously *against* the laws of scientific propagation. In effect it castrates the finest animals in its flocks. It encourages the lowest scavenger to breed *ad libitum*, and forbids Father Hyacinthe to leave a single copy of himself behind him. "The Shakers are in the same position as the Catholics. They claim to be the noblest and purest people in the world; a sacred generation, raised by grace high above the rest of mankind; and yet with full power to propagate their kind, they virtually castrate themselves, and expend their labors and wealth on their comfort, and on misbegotten adopted children, leaving the production of future generations to common sinners."

The author claims for the institutions "that shall at some future time supersede marriage and its accessories," that they must not lessen human liberty; must not injure HOME. "The socialisms and spiritualisms, which have engaged public attention in the last thirty years, seem to have weakened the very constitution of society. Free-love, easy divorce, fœticide, general licentiousness, and scandalous law-trials in high life, are the symptoms of the times."

What the institution is that is to improve upon and supersede marriage, the author does not indicate; nor are there pointed out any modes of experimenting in stirpiculture, nor of enforcing scientific propagation when the rules are learned.

NEW REMEDIES: A Monthly Trade Journal of Materia Medica, Pharmacy, and Therapeutics.

This is an attractive and valuable 32 pp. large 8vo monthly, edited by F. A. Castle, M. D., and Mr. Charles Rice. It contains interesting original and selected matter bearing upon the subjects indicated in the title; the abridgments of important papers constituting a prominent feature. The Market Reports, and Prices Current of New Remedies, are peculiarly accurate. The circulation is stated to be 7,000; the advertising patronage is liberal, and of a high class. The subscription price is $1.50 per year (including postage); and the publishers are Wm. Wood & Co., 27 Great Jones St., New York City.

FURTHER NOTES ON "INCLUSIONS" IN GEMS. By Isaac Lea, LL. D. Philadelphia: 1876.—A continuation of investigations of microscopic crystals contained in gems, reproduced from the Proceedings of the Academy of Natural Sciences of Philadelphia.

A CATALOGUE OF THE PUBLISHED WORKS OF ISAAC LEA, LL. D., FROM 1817 TO 1876.—A list embracing 223 papers contributed to various learned societies.

THE SPATHIC IRON ORES OF THE HUDSON RIVER. By R. W. Raymond. In full in *E. & M. Jour.* May 20, p. 492.

GEOMETRICAL CHEMISTRY. By Prof. Henry Wurtz. In full in *American Chemist* for March.

INDUSTRIAL AND BUSINESS DEPARTMENT.

The Publishers, having seriously felt the need of a Department in their REVIEW in which Manufacturers, Inventors and others might have the opportunity of presenting and advocating special business interests, have decided upon opening an *Industrial and Business Department*, in which those above named may present their specialties in detail, and with that particular reference to business interests which the Publishers must necessarily exclude from the body of the REVIEW.

IMPROVEMENT IN WIDE LEATHER BELTING.

In the following description of a patented improvement in the manufacture of wide leather belting, the term *hide* means the skin of the animal tanned whole, the back being in the center lengthwise. The term *side*, means one of the halves of the hide made by cutting down the middle of the back.

The ordinary method of making wide two or more ply belts, as shown in cross section by Fig. 2, is stripping pieces of the width required from the centres of hides, splicing the ends, and on this one ply building up layer after layer, as many as required, breaking joints with each layer lengthwise of the belt; the width of each layer being, of course one piece. This brings the back centre (marked B. C. in the cuts) or firmest part of the leather, immediately in the centre of the belt, the edges being composed of leather from the side portions of the hide (S.E.) which is yielding in comparison with the middle. The above construction has three disadvantages:—

1st.—All pulleys being more or less convex on their faces, the middle of the belt being firm and not conforming to this convexity, and the edges of comparatively loose fibre, the consequence is that the edges of the belt will not bind down to the edges of the pulley, and after running a short time will stretch more, owing to their loose fibre, and the absence of that lateral support which the central portions have. Thus only a part of the width of the belt is effective, thereby transmitting much less power than if all the surface contact was fully available.

2d.—The centre or tight portion of the belt bearing the greater part of the strain, and the other parts not relieving it, will consequently give out proportionately quicker than if the strain was equalized.

3d.—Along the portion of the hide over the back-bone, full or humpy places are often found, caused by the shape of the animal, and this part of the leather being more or less hard and stubborn, it is difficult and often impossible, *in the whole hide*, to work them perfectly flat; and after being made into belting, they present to view an uneven surface all along the centre of the belt, which will never lay down flat to the pulley, thus preventing other parts from touching, and a corresponding decrease in surface contact, even though the edges were supposed to bear.

The above disadvantages are overcome by the following construction:—

In making wide double belts, hides are cut along the middle, back-edges (B. E) turned outward, and the side-edges (S. E.) inward, inserting a side-centre (S. C.) piece, so as to break joints widthwise, as shown in Fig. 3, Fig. 1 being a perspective view of the same.

In three-ply belts the same method is carried out, as shown in Fig. 4.

Fig. 1.

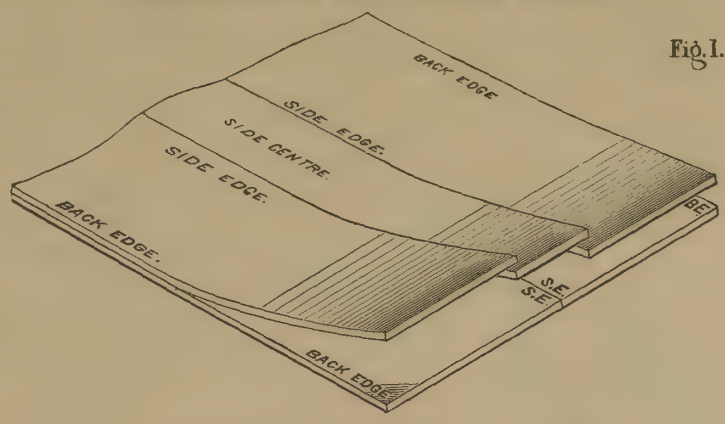


Fig. 2.

Fig. 3.

Fig. 4.

There are various other arrangements of the pieces which can be used advantageously in certain cases.

The disadvantages of the ordinary method heretofore enumerated are overcome as follows:—

1st. The edge portions of the belt being of firm, solid, and unyielding leather, and the middle portions of leather of looser fibre, and more yielding texture, it is evident that, after running a short time, the middle will give to the higher part of the pulley, and the edges will not only bind down, but will also afford that lateral support which will prevent the middle stretching as much as it otherwise would, and thus giving an even bearing the whole breadth of the belt, and consequently the greatest amount of pulley contact.

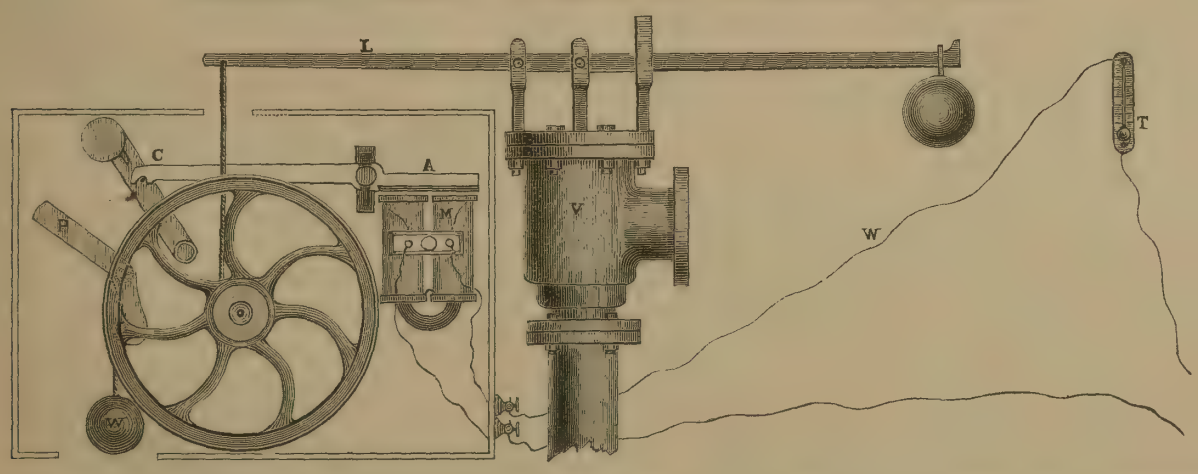
2d. When the middle of the belt becomes stretched, and allows the edge portions to bed themselves down to the pulley, the working strain will be distributed over the entire width, thus preventing wear on any one part alone.

3d. Cutting down the middle of the hide enables the currier to work out any uneven or full places, the surplus being cut away in straightening.

For belts of 16 to 48 in. or wider, no other plan of making, or material other than solid oak leather, can approach for effectiveness and durability the arrangement described and illustrated above.

This invention bears date of patent June 15th, 1875. The patentees and manufacturers are Alexander Brothers, 410 & 412 N. Third Street, Philadelphia. The belt driving from the great Corliss Engine, shaft No. 3, Machinery Hall, is made in this manner.

SANDERSON & PROCTOR'S AUTOMATIC FIRE EXTINGUISHER AND ALARM.



In submitting a description of this invention for the Automatic Extinction of Fires in Mills, and all buildings where steam is used, it may be well to offer a few prefatory remarks on fires in general.

Heat, although the great universal motive power of nature, upon the agency of which almost exclusively depend all results obtained in the universe, if it escapes the guiding reins of those hands which make it subservient to comparative weakness—a willing tool, assisting in the production of the necessaries and luxuries of the dweller on this planet—if it breaks forth from its guard, it becomes the terrible motive power of destruction. And who can say for a moment that his property or even his life is safe from its ravages? We know not what a day may bring forth. "During the past year the Fire Insurance Companies in England, have paid £600,000 for losses on cotton mills alone," and this sum does not nearly represent the total loss. How many families must have been thrown out of employment, and how many lives jeopardised in one branch of industry alone consequent upon such destruction? And the risk instead of decreasing is increasing year by year to an alarming extent, and as a consequence, Fire Insurance Companies are obliged to raise their rates, so much so indeed as to be exceedingly burdensome to insurers. Property destroyed by conflagration must, moreover, be considered a national loss; it represents so much capital lost to the nation. Nor would the means to render fires harmless dispense with the necessity of insurance offices. No, No! A fire cannot be put out before it burns, and when it does, something beyond atmospheric air must be consumed, and any invention calculated to reduce this consumption deserves favorable consideration. But those who have suffered from the calamity of a fire will best appreciate any attempt to reduce its ravages.

It cannot but strike the ordinary observer that the present method of extinguishing fires is, in spite of the greatly improved and yet improving means of applying water, still very crude, the amount of valuable property destroyed year after year, proving to demonstration that there exists great room for improvement. *First* the *fire must be discovered*, and it very often attains serious proportions before its discovery; then the alarm must be given, the men and appliances appointed to their places in order to discharge volumes of water upon the flames. And all this has to be done at the time when every moment is of the utmost importance to prevent the fire from getting firm hold of the building, for should it once gain the mastery, all efforts are then directed to save the adjoining property. Then again it is perhaps found at the last moment that the appliances are leaky and unfit for use, or that the water supply is limited. But under the most favorable circumstances it is usual for the water to do as much damage as the fire.

It has long been known that *steam* is an *absolute* extinguisher of fire, but for want of the apparatus for throwing it on a fire *simultaneously* with its outbreak, it has not hitherto been adopted to any great extent. There are many cases on record in which steam, set on by *accident*, has quickly extinguished fires, which in similar circumstances have proved serious affairs. But how to have it always in readiness night and day, automatic in its action, independent altogether of any fallible watchman in charge, and applied in any part of an extensive building, have been found to be greater obstacles in the way of its adoption. The difficulty, however, is overcome by a self-acting apparatus, the action of which may be thus shortly described:—By a novel (yet simple and certain) application of electricity, immediately a fire breaks out in any room, a valve is opened in the boiler, communicating with a valve in the room where the fire has broken out, by which the room is quickly filled with steam which envelopes the fire, and quickly and effectually extinguishes it, at the same time raising a loud alarm by means of a whistle. The way this is accomplished is as follows:—A number of thermometers, set to go off at any given temperature, are placed in different parts of the room, which are in connection with a galvanic battery, and with the valves above named; as soon as a fire breaks out, the mercury in the nearest thermometer rises, completes the electric circuit, and instantly opens the valves referred to. The room, however, and its contents receive no injury from steam, except a slight damping, which is trifling in comparison to the damage done by water in almost every instance. Simultaneously with the working of the apparatus, an electric alarm and indicator showing the room on fire, are set in action, thus giving prompt notice of the fire. The electric alarm and indicator may be fixed anywhere, at any distance from the mill, say, the master's bedroom, or watchman's hut. *It will therefore be apparent that the action of the apparatus is almost simultaneous with the commencement of the fire, the the only time it can be successfully operated upon.*

This apparatus may be seen in practical operation in the British Section, Machinery Hall. Rights for this country are for sale.

THE "GOODES" SEWING MACHINE.

One of the most ingenious and interesting special machines on exhibition in Machinery Hall, is the "Goodes" Sewing Machine, which is designed to accomplish plain or ornamental stitching with either one or two needles, in connection with a single shuttle. This shuttle, in order to pass through the loops of the threads from two needles at once,

has a transverse throw. The machine employs the drop-feed, so arranged as to effect the sewing either in parallel straight lines, or in angles, or in parallel or interlacing waving motions.

The ornamental interlacing stitches and overseams are produced by rotation of the needle-bar, using in connection with a single shuttle, two needles, one of which partially rotates about the other.

When two needles are used on parallel seams, a double amount of work is produced; and this work being interlocked by one shuttle-thread, is quite elastic and mutually sustaining. In shoe work, this feature is of special value, as preventing the breaking the thread of the row nearest the edge of the goods.

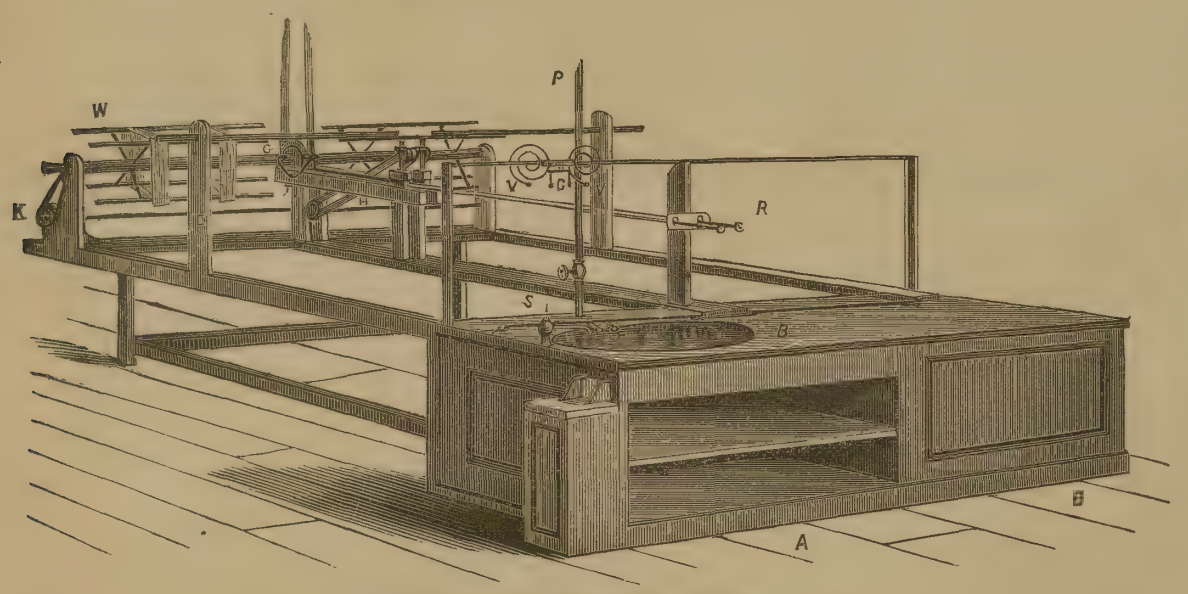
In overseaming, by laying one piece of the goods on top of the other, one needle may run *through* the goods, and the other passes over the edge; or, by laying one edge each of two pieces of goods side by side, a needle may pass through the edge of each at the same time; securing a firm seam, with hidden joint, being ornamental, and using up material that would otherwise be wasted. The stitching effected is very durable and ornamental, and *not capable of being unravelled.*

The rotation of the needle-bar required to effect overseaming and some of the ornamental stitches, necessitates a mechanism which will prevent the thread from being wound around the needle. Happily the inventor has made for this purpose a mechanism of great simplicity, and worthy of adoption in other fields.

In 1874, when this machine was first exhibited at the Franklin Institute Semi-Centennial Exhibition, the award of a silver medal—the highest prize—was made. About this same time, the invention was still further honored by the award of the "Scott Legacy" Medal and Premium, from the Franklin Institute "Committee on Science and the Arts."

Since this date, Mr. Miller, (to whom is largely due the successful overcoming of the many mechanical diffiulties incident to the very ingenious invention) has simplified and still further improved the Goodes machine.

The machine itself, with a full line of samples showing its capabilities, may be seen in operation in Machinery Hall, column D. 70.



SILK COCOON WINDING MACHINE,

By Captain Louis Ribeiro de Souza Rezende, of the Sericultural and Rural Plantation "Bananal d'Itaguahy," near Rio de Janeiro. Exhibited in the Brazilian Section, Machinery Hall, U. S. Centennial Exhibition.

This apparatus, which is shown in perspective in the accompanying illustration is double. Each half consists simply of the following essential parts, of which the mode of operation is described.

(1.) A metal-lined basin, (*b*) supplied by a faucet (*s*) with cold water, heated to such temperature as may be desired, by steam from the pipe (*p*).

(2). Immediately above and back of the basin is a transverse bar (*h*), which, bears projecting horizontally from it, two stems carrying the *filières* (*f*), which are porcelain disks half an inch in diameter, and each pierced in its center with a small vertical hole. This horizontal bar has a slight traversing motion.

(3). Above and across the machine is a transverse bar carrying the *croiseur* or *twister* (*c*), which is a tiny reel with vertical axis, and set in motion at will, by a train of clock-work.

(4). At each side of the *croiseur* is a *trembleur* or vibrator, (*v*) which is a spiral spring bearing at its free end a loop fitted with a heart-shaped glass plate. Midway of the machine rise standards which bear a reciprocating cross-bar, fitted with a triangle of wire, apex downward.

(5). At the back of the machine are standards bearing a reel operated by a crank or by power, the belt being thrown into operation by a clutch actuated by the rod (*r*).

The operation of the machine may be thus briefly described.

The cocoons (containing the dead chrysalides) being placed in a basin of hot water, are softened and rendered more easy to unravel. The free or outer ends of the cocoons are gathered by beating the floating mass gently with a stiff brush of twigs. Two sets of six each of these being selected, are passed upwards through the holes in the porcelain *filières* (*f*), are crossed, passed through the loops on the croiseur, through the niche in the glass bushing in the vibrators, then through loops in the triangle, and then to the reel. The machine being then set in operation by the hand crank or by the belts, the delicate threads are unwound from the bobbing cocoons, brought together, intimately twisted, and wound on the reel, which is seen to contain two hanks of the twisted thread. With good cocoons of the Japanese race, a skilful operator on this machine may outstrip many times the results of unaided hand labor.

This machine is the sole property and manufacture of Captain Rezende, who brings it here and places it on exhibition to show practically the operations of Brazilian sericulture. Captain Rezende shows how Brazilian silk-culture may combine profit with pleasure. The accomplished Captain is the representative of agriculture and mechanics on the Brazilian plantation. His amiable wife and pretty children occupy themselves with the silk-winding; and show as no other representation would do, that silk-culture is a light and not unpleasant occupation. As regards the profit accruing, M. Rezende states that the Brazilian worm has *six to eight* seasons or crops; that of France and China yielding but one or two.

"With one ounce of eggs, in a period of 45 days, 40,000 silk-worms can be raised. Admitting a loss of 15 per cent. there would be yet 24,000 cocoons, or 85 lbs. At the rate of 400 cocoons per pound, and at the French market price of 50 cents a pound, this gives $42, which the women and children of the family can earn six or eight times in a year; thus bringing to the common fund of the family from $252 to $336."

Accompanying the silk-winding machine is a very complete and interesting collection showing the eggs of the silk-worm; live worms hatched from these, and feeding ravenously upon the leaves of the *Morus multicaulis.* There is a collection in vials, showing the worm at each day of its short life, from its emergence from the egg to the 25th day, when it forms around itself the marvelous cocoon, (in which it remains two weeks). The emergence of the chrysalis is shown, and also the male and female moths. In a series of vases are cocoons, (gray, white, and yellow,) of the various races; and in cases may be seen collections of every variety of raw and spun silk known to the grower and the dealer. In tiny pigeon-holes are hundreds of cocoons, there woven by the moth, which seeks retirement in narrow limits. In other cases are shown the French instruments for weighing and testing the fibres.

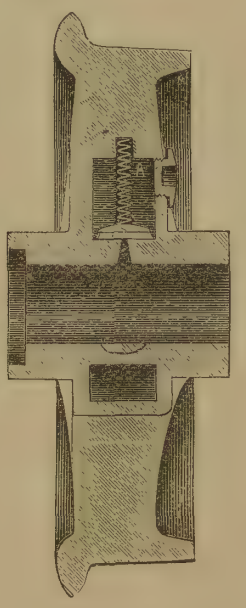
In the same handsomely fitted-up alcove is a frame showing some of the curious and the gorgeous insects of the dense Brazilian forests. There is also a full series of Brazilian coins and medals, and marks of distinction; and Brazilian urban and rural views. The whole exhibit (which is the exclusive property of Captain Rezende) is one of unusual interest and importance, and worthy of an extended visit and critical inspection. Should the visitor be fortunate enough to speak Portugese, French, or German, he may obtain from the obliging proprietor and exhibitor the most detailed information desired.

There is in course of preparation an extended English catalogue of these exhibits.

Further mention of the exhibits made by the government and people of our great tropical neighbor, will find place in these columns.

BRYANT'S SELF-LUBRICATING CAR-WHEEL

Works substantially as follows: A spiral spring running through the centre of the oil chamber, bears on its lower extremity a sponge which caps the feed orifice (see cuts). The centrifugal force consequent on revolution tends to throw the oil to the upper portion of the chamber and thus prevent an excess being fed out below, while the spiral spring, acted upon by the jar and vibration and motion, forms a conductor that keeps the sponge saturated with oil and feeding a small quantity (amply sufficient for lubricating purposes,) into the orifice, whence it is drawn to fill the vacuum caused by the action of the friction surfaces, the hub and axle, upon each other.



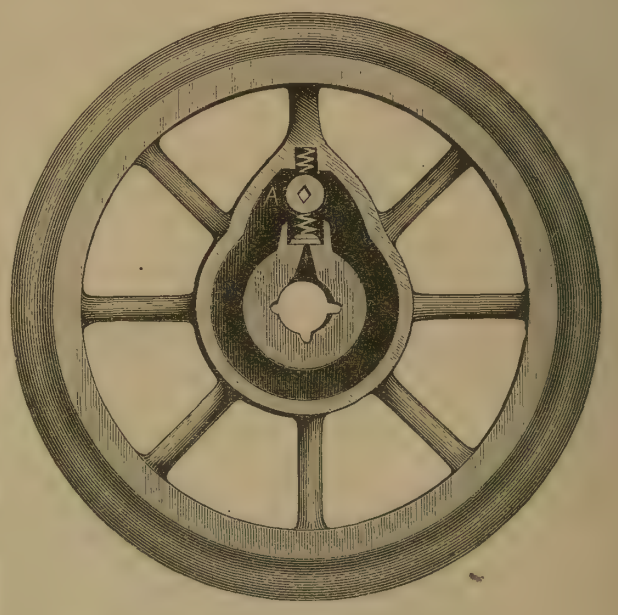
When the wheel is at rest, the supply ceases, as the sponge pressing steadily on the mouth of the orifice prevents leakage. Small chambers on the inside of the hubs receive the surplus oil, it any, and feed it out again as required.

The oil chambers need to be filled only once in from three to eight months, according to size of wheel and use. As the chamber is sealed up, no dirt or drying influence can get to the oil. There is no breaking, firing, or removal of waste saturated with oil on account of being clogged with dirt.

There is no setting and sliding of the wheels, as often occurs with those rigged solid to the axles. If a wheel becomes worn or by accident broken, it can be replaced without taking the pair together with the axle to the repair shop.

Experienced railroad men concede that at least from ten to twenty-five per cent. may be saved by adopting this new principle, and it is certainly worthy the attention of builders.

Mr. Bryant has several wheels running on exhibition in Machinery Hall, E–67, among which is a carriage wheel which makes 350 revolutions per minute, or a running distance of over 330 miles per day, and is expected to run at that rate for at least 100 days without further oiling, which



will make in all over 33,000 miles, a thing unprecedented in the annals of self-lubricating machinery.

Mr. Bryant also has pulleys built on the same principle, a number of which are working through the Hall.

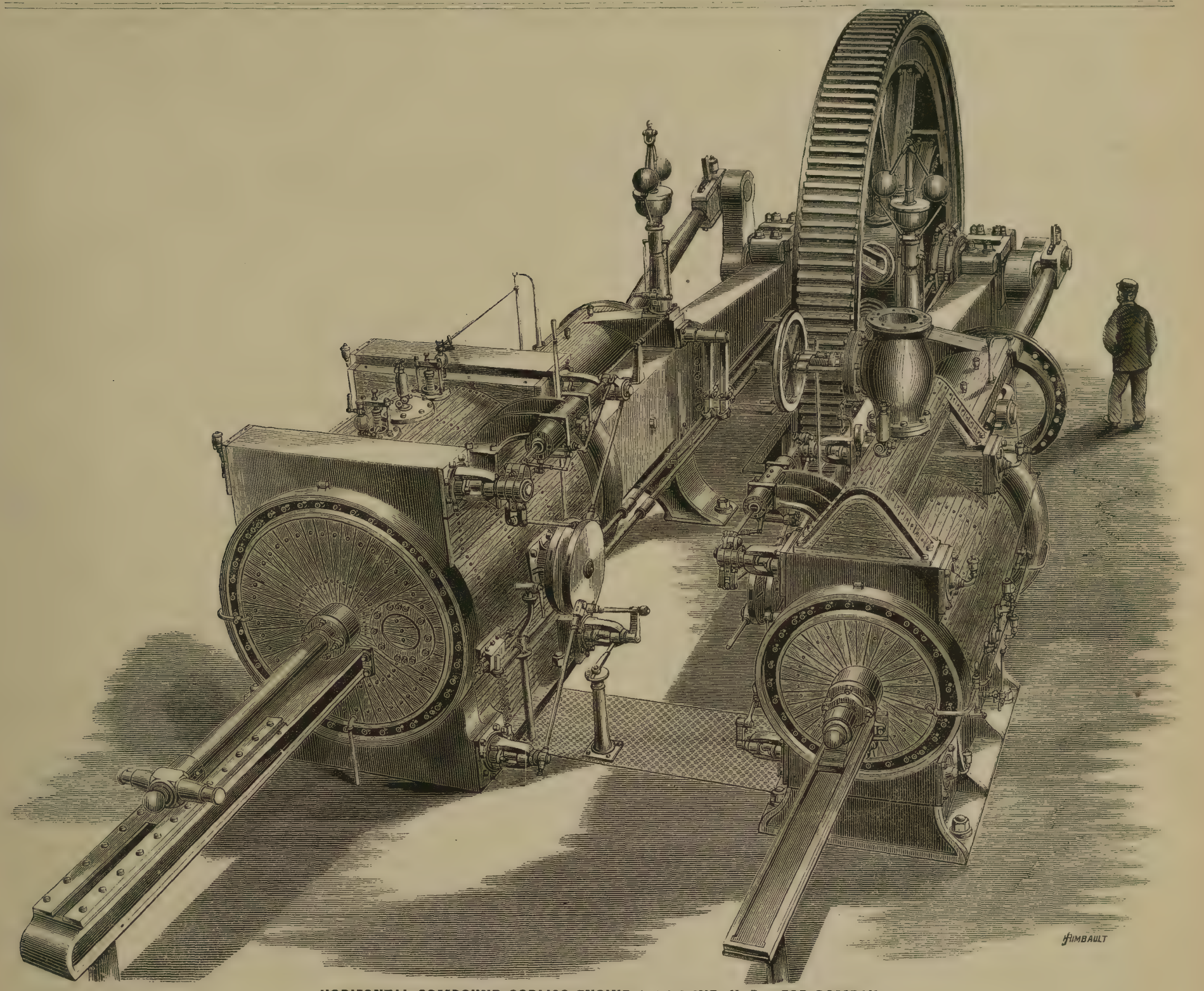
Rhé Electromètre.—A new device by Mariani, to investigate electrical discharges between the atmosphere and the earth, has a copper wire coiled upon a pasteboard tube, and carrying a traversing magnetic needle upon a pivot above the coil. A small iron bar is inserted axially within the coil. The apparatus is placed with the coil east and west. A spark of high tension passing through the coil magnetizes the bar, which deflects the needle east or west, according to the spark's direction. The iron bar must be de-magnetized by heating before using again. [Abst. from *Sci. Am.* May 13, p. 303.]

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. 2. PHILADELPHIA, JULY 8, 1876. NO. 1.



HORIZONTAL COMPOUND CORLISS ENGINE (1000 IND. H. P.), FOR BOMBAY.

MR. GEORGE ALLAN, M. I. C. E., ENGINEER ; MESSRS. DOUGLAS & GRANT, CONSTRUCTORS.

We beg to acknowledge our indebtedness to the editors of our able cotemporary, *Engineering*, for the accompanying engraving and description :

"The considerable extension going on in Bombay of the cotton manufacturing industry has much excited Manchester of late, and we doubt not that, with such indomitable energy and enterprising spirit as the native merchant princes of Bombay have always evinced, it will be difficult if not impossible to check it even by the withdrawal of the import duty on Manchester goods. With indigenous cotton and cheap labor, there appears, by the past success of the mills in Bombay, to be a good margin against the cheaper fuel and machinery, as well as cheaper capital, in England. We may, therefore, expect to see not only additional mills springing up from time to time, but the present mills enlarged.

"In our illustration in this week's issue is a perspective view of a fine pair of Corliss compound horizontal engines for the Fleming Spinning and Weaving Company, Bombay, who have found it necessary to replace their old engines with others of considerably greater power. This extension is being carried out under the able and energetic management of Nursey Kessowjee, Esq., the managing director of the Company, who has ordered the engines of Messrs. Smith, Fleming, and Co., 17 and 18 Leadenhall-street, London, through Messrs. W. Nicol and Co., their Bombay house. The specification of the engine was prepared by Mr. G. Allan, Memb. Inst. C. E., and the contract carried out under his superintendence by Messrs. Douglas and Grant, engineers, Kirkcaldy, N. B.

" The engine with 80 lb. of boiler pressure and cutting off at one-fourth in the high-pressure cylinder, will give an effective ratio of expansion of about 10, and with the piston speed of 440 ft. per minute will develop 1000 indicated horse power. The engine is designed to work at a higher pressure than this, but at first it will have to develop the above power with only 60 lb. of boiler pressure, in consequence of the present old Lancashire boilers not being sanctioned for more.

" The high and low pressure cylinders are respectively of 40 in. and 66 in. in diameter, and 6 ft. stroke. Both are thoroughly steam-jacketed in bodies and ends. The valves are of the well known Corliss type, the steam valves having an improved automatic releasing gear. The cut-off in the high-pressure cylinder is entirely controlled by the governor, whilst the low-pressure cylinder is similarly fitted, but has the addition of an adjustment for a uniform point of cut-off. The pistons, as well as the Corliss valves, work in cast-iron liners carefully fitted into bored seats ; these liners are cast of a special mixture of tough and hard iron.

"The cranks are at right angles and the intermediate receiver is formed by the available space underneath the high-pressure cylinder, the short connecting pipe and the passage round the low-pressure cylinder. The piston rods, which are of steel, 6¼ in.

in diameter, are in both cases carried through the back covers and supported by flat slipper guides. The main frames are of the usual Corliss pattern and of very great strength; each frame is cast in two parts, joined with flanges and turned bolts in the most substantial manner. The brasses of crankshaft necks are each in four sections, with a wedge adjustment, so that the brasses can be tightened or eased while the engine is at work. The crankshaft is of steel, having necks 16 in. in diameter and 24 in. long; the centre is 20 in. in diameter. The crank pins are of steel, 10 in. by 10 in.

"The geared fly-wheel is 20 ft. in diameter, 24 in. broad on face, and 5¼ in. pitch. The teeth are of cast iron, and capped at both ends up to the pitch line, the rim and caps being turned. The rim consists of two rings of eight sections each, which break joint with one another, and are joggled and keyed together; the inner ring being attached to the arms with dovetailed keys and turned bolts. The arms are turned and fitted, tapered with cotters into the centre boss of wheel. The weight of the fly-wheel with its shaft and cranks is about 53 tons.

"The pinion driven from fly-wheel is 6 feet, 4½ inches in diameter. The rim and teeth are cast together, but separate from the centre and arms, to which they are secured by dovetailed keys, having first been turned and bored. The second motion shaft is on a level with crankshaft, and is carried on heavy cast-iron brackets, which are rigidly bolted to main frames of engine.

"The condenser is close behind the low-pressure cylinder, and is fitted with Mr. Allan's improved distribution plate, which splits up the jet water so as to present the largest possible amount of cooling surface to the steam within the first foot of its fall; in this instance about 180 feet of sheet water is presented to the steam. The air pump is 46 inches diameter, and 3 feet stroke, worked from the prolongation of piston rod by a wrought-iron bell-crank. We cannot too highly commend the plan adopted in this instance of arranging to have the air pump and condenser in the daylight instead of the usual plan of burying them out of sight, and we understand this is followed by Mr. Allan in all his condensing engines.

"Provision is made by requisite pipes and valves for working either cylinder by itself if necessary, and for exhausting into the atmosphere; whilst the low-pressure cylinder is of ample strength to work with a steam pressure sufficient to drive the entire mill itself should necessity require it. Each cylinder has its own governor, and each is, in fact, a complete engine. Generally, steel is employed throughout in place of wrought iron. The cylinders are fitted with complete indicator gear, and are thoroughly felted and lagged handsomely with polished mahogany.

"The engine was run under steam and tested by the indicator at the makers' works in the presence of several engineers and other gentlemen most competent to judge, all of whom were highly satisfied with its well proportioned appearance and the excellence of its finish."

EXTRACTION OF GOLD FROM AURIFEROUS ORES.

BY GEN. T. J. CRAM, U. S. Corps of Engineers.

(*Concluded.*)

IV.—EXPERIMENTAL RESULTS OF WORKING THE CROSBY PROCESS UPON A LARGE SCALE.

Being impressed with this new process, an association of gentlemen engaged the inventor and patentee (A. B. Crosby) to erect a mill to work by his process, in 1872–3, at the "Old Dominion Mine," Va. Tons of sulphurets from it and other mines were worked in that mill, and the results were a saving of 86 per cent. as the least, and 93 per cent. as the average or mean of all the gold the assays showed the ore to contain before treatment.

In 1873–4, the machinery from that mill was moved to the Gold Hill Mine, N. C., and put into a mill then and there erected, on a scale for treating twenty tons of ore per day. This mill was worked upon 19 separate lots of sulphurets from that mine, varying in quantity from two to thirty tons per lot, in all 214 tons; assaying from $5.16 up to $78.09 per ton per lot; the mean or average assay of all the lots being $15.42 per ton in gold.

By a careful examination of the records of these experiments, it is shown that the mill saved from 95 to 99 per cent. of the gold in the ores, and some of which were obstinate in tellurium.

Again, in the winter of 1875–6, a superior Crosby Mill has been completed at the "Hall Mine," in Lyman, N. H., and run upon refractory sulphuret gold ore of very low grade—thus, a third time testing the process and expense in working upon a large scale.

The report of the expert who made the tests of this mill, declares the process of capacity to save 90 to 95 per cent. of all the gold in sulphuret ore; and speaks in high commendation of the mill in all parts, likewise of its performance, simplicity, durability, the small quantity of fuel, and the small amount of hand labor required in the operations.

In each of these three mills experts were employed; not, however, by the inventor, nor owners of the patent, but by outside capitalists desirous of reliable experiments, in order to thoroughly test the process.

In every instance these experts have reported the saving of gold more in per cent. and less in cost for the treatment than claimed by the inventor in his caveats.

In the foregoing experimental workings of the three mines, we have satisfactory proofs of the admirable adaptation of this process for profitable working upon low as well as high grades of sulphuret gold ores.

We need no further tests to convince the most skeptical, that the vast quantities of sulphurets of numerous mines already opened in our country and in foreign lands—heretofore believed of small value—can now, by this process, be made highly remunerative.

V.—PROFITABLENESS OF WORKING BY THIS PROCESS.

Taking generally the mines in our country where it would be prudent to erect these mills, the average cost of a mill for working 20 tons per day, including the building, machinery, and all other requisites, without the copper apparatus, is $30,000; with it, $36,500. The copper-saving appliances should be put in when the ore, besides the gold, contains 3 per cent. or more of copper. This average cost would be much diminished at those mines where appropriate buildings, stamps, and steam power already exist, and which could be utilized as parts necessary for the Crosby Mill.

The *average* of the ores from the mines, taking those already on the surface of the ground, in the "dump heaps" and those yet in the depths of the mines, would cost $4 per ton, delivered at the mills.

The average cost of treating the ore after delivery would not exceed, including wear and tear of machinery, $4 per ton at mines where water and wood are to be had at reasonable prices. Prudence would forbid placing a mill where these necessaries could not be commanded in abundance.

The average saving by this process will be 93 per cent. of all the gold in the ore. A higher percentage may be saved, but to continue working to save 96 to 99 per cent. would be like "splitting hairs."

Fuel might be as high as $12 per cord, and the mill would net a profit on ore assaying as low as $15 per ton. But for the above average cost of treatment, the mill would return a net profit, running on ore assaying as low as $9 per ton; and for all higher assays, the profit would be enhanced above this minimum in proportion to the richness of the ore, though in a higher proportion than the direct ratio of the increased value shown by the assay.

Upon ores of $40 average, the net profit of the mill would be $29.20 per ton of ore.

The mill could be run 280 days in the year, allowing for all stoppages—those for "cleaning up" inclusive.

The daily profit would, on such ore, average $584, and the yearly profit $163,520.

VI.—LOCATIONS FOR THE CROSBY MILLS.

A few common-sense hints upon this question will not be out of place here.

Three points should be carefully weighed in selecting a mine at which, or near which, to establish a mill.

Firstly. The quantity and richness of the sulphuret the mine will furnish.

Secondly. The supply of fuel and water, and their prices.

Thirdly. The cost of mining and delivering the ore at the mill site.

There are many "worked-out mines," so called, down to the water level, where the old tailings and dumped neglected ore would justify the construction of a mill.

The first point can only be safely decided by a competent practical metallurgist of experience, who should be employed without stint of compensation, to test the quantity richness and quality of the ore of the mine, so as to make sure of a large supply of profitable raw material, before deciding to establish the mill there. In regard to assays, great caution is requisite, as every experienced mining engineer knows. It is the average of the assays of many parcels from many parts of the vein—poor, good and rich—that determines the value of the ore in general, rather than the assays of particularly selected specimens.

Many investors have been woefully disappointed from allowing the imagination to be inflamed, and expectations of future profit exalted by assays of specimens.

But now, owing to metallurgic skill and the advance in the knowledge of mining and reducing, there is no excuse for such mistakes; and the production of gold from the raw ore may be conducted with as much freedom from chance or speculation as the manufacture of flour from the raw kernel as it comes from the sheaf.

In regard to the second point—supply of fuel and water—these will depend upon the quantity of ore the mine shows fit for working; no one should presume to put a mill where these are not to be had, nor where they would be scarce or extravagant in cost, unless the ore should be great in quantity and very rich in quality.

In reference to the third point—cost of mining and delivering the ore—this should be decided on the spot by a competent practical mining engineer.

VII.—INVESTMENT OF CAPITAL.

At the present time, many branches of manufacturing industry are lying dormant or working on a small scale of production; an increase of product only depresses the value of what is already on hand.

Millions of dollars, heretofore invested in the purchase of iron and coal mines, in their improvements, in hoisting machinery, in the mills and appliances for manufacturing merchantable articles, are completely idle; and should this depressed condition continue, it will not be many months before this outlaid capital will be sunk out of sight. What has just been said of products from iron and coal also applies to many other manufactured products.

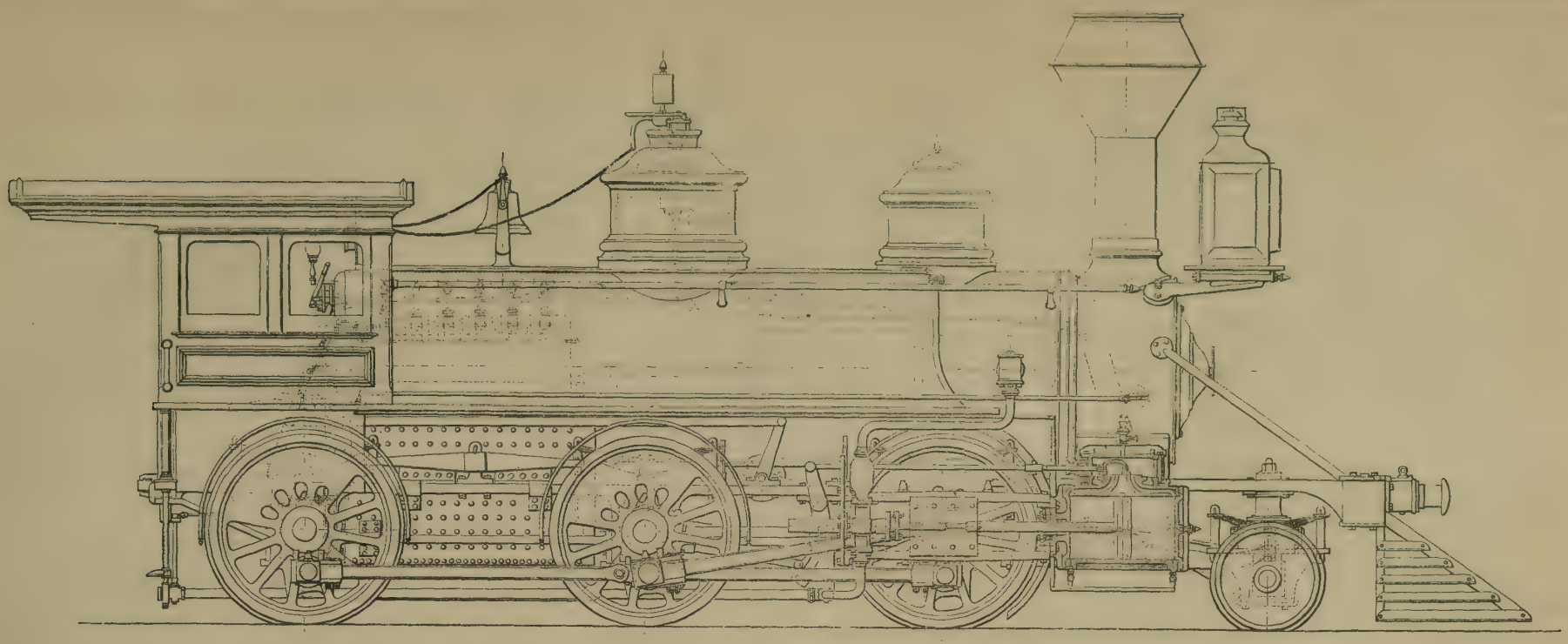
Even in prosperous times, products, whether by the furnace, the foundry, the rolling mill, the spindle, the loom or the last, are subject to such fluctuations in price that the producer is seldom for any length of time assured of his profit, nor can he at once, when need presses, convert his product—be it ever so valuable—into its equivalent ready money.

Now, from the foregoing exposition in respect to the milling of gold ores, it is believed that the production of gold may be made a business absolutely free from such losses as now pertain to the other mentioned industries, for several reasons, viz: The gold product cannot fall below par; the results would be very sure; prudence being exercised in the location of the Crosby Mills, no amount of competition can depress the business; and unlike other productions, the more gold produced the better for the country's business generally; certainly, until enough shall be produced to redeem the government paper in circulation, to meet the interest on the public debt, and by degrees to extinguish the whole principal as this debt becomes due.

It is not extravagent to say all these may be accomplished by utilizing the sulphuret gold and silver ores now in the mines of our own country, without any resort to foreign countries for the coin for these much desired ends. To do this more readily, silver of the old standard, *viz*, 371¼ Troy grains to the dollar, should be made a legal tender as well as gold.

In conclusion, it may be said that the small amount of capital required in the first outlay for establishing a mill, brings the business of gold-producing from the idle sulphurets within the means of moderate money-holders; and large returns of net profit would be more certain than from investments in many other popular branches of industry.

NOTICE:—From and after the present issue the POLYTECHNIC REVIEW *will appear as a weekly. This change is made in accordance with the original plan of its proprietors, and they gladly accord to the numerous friends their journal has made, the advantages incident upon its more frequent appearance. The progress of the paper has been both rapid and substantial, and the change above noted will enable its editors to more fully satisfy their sense of responsibility for the promises made in their prospectus, and materially add to the usefulness of their enterprise. To the many friends and patrons of the* REVIEW, *its editors send their greeting and warmest thanks.*



From the Illustrated Catalogue of the International Exhibition 1876.

CENTENNIAL EXHIBITION OF BALDWIN LOCOMOTIVE WORKS.

II.

FREIGHT LOCOMOTIVE, "MOGUL" PATTERN.

For the Dom Pedro Segundo Railway of Brazil, five feet three inches gauge. Fuel, Bituminous Coal.

LOCATION: SECTION E 6, COLUMNS 41–42.

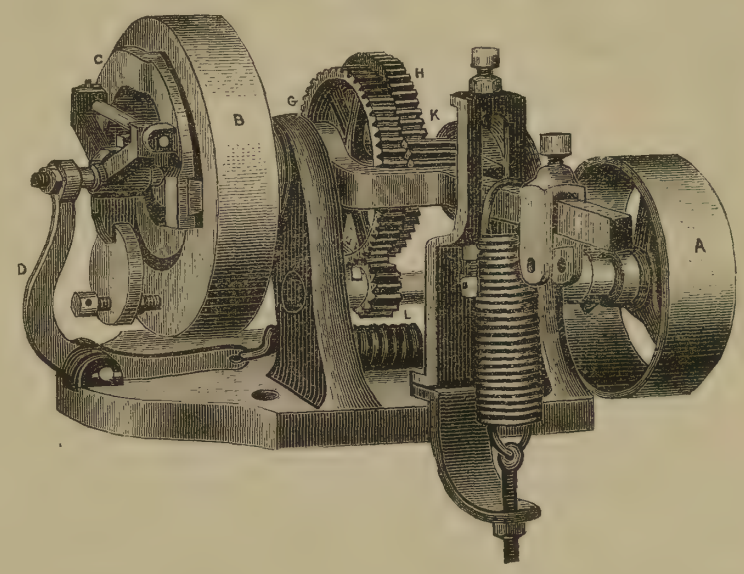
CYLINDERS.			
Diameter	1 ft.	6	inches.
Stroke of piston	2 ft.		
Length of steam-ports	1 ft.	4	"
Width of steam-ports		1¼	"
Width of exhaust-ports		2½	"
Travel of valve		5⅜	"
Outside lap of valves		¾	"
Inside lap of valves		1/32	"
Exhaust nozzles—double, variable.			
WHEELS.			
Diameter of driving-wheels	4 ft.	6	"
Diameter of truck-wheels	2 ft.	6	"
Distance between centres of front and rear driving-wheels	15 ft.		
Total wheel-base of locomotive	22 ft.	8	"
Total wheel-base of locomotive and tender	44 ft.	3	"
Diameter of driving-axle journals		7	"
Length of driving-axle journals		8	"
Diameter of main crank-pin bearing		4½	"
Length of main crank-pin bearing		4½	"
BOILER.			
Outside diameter of smallest ring of boiler	4 ft.	3	"
Thickness of boiler plates (iron)		½	"
Number of tubes	159		
Length of tubes	11 ft.	2¾	"
Outside diameter of tubes		2	"
Length of fire-box inside	5 ft.	5	"
Width of fire-box inside	2 ft.	11½	"
Depth of fire-box inside	5 ft.	3½	"
Thickness of fire-box plates (copper), side, back, and front sheets		½	"
Thickness of flue-sheet		3/8	"
Thickness of crown-sheet (steel)		3/8	"
Square feet of grate surface	16		
Square feet of heating surface in fire-box	103		
Square feet of heating surface in tubes	937		
Total square feet of heating surface	1040		
TENDER.			
Number of wheels	8		
Diameter of wheels	2 ft.	4	"
Diameter of tender-axle journals		3¼	"
Length of tender-axle journals		7	"
Capacity of tank	2000 gallons.		
WEIGHT.			
Weight of engine in working order	80,000 pounds.		
Weight of engine on driving-wheels	68,000 "		
Weight of tender, empty	20,000 "		

MATERIALS.

Boiler, J. L. Bailey & Co's "Pine" Iron; *Fire-Box*, Hendricks Bros.' Copper; *Tires*, Standard Steel Works' Crucible Steel; *Engine, Truck and Tender Wheels*, Ramapo Wheel and Foundry Co's Double-Plate Chilled Wheels; *Flues*, W. C. Allison & Sons' Lap-Welded Charcoal Iron Boiler Tubes; *Injector*, William Sellers & Co.: *Steam-Gauge*, Buffalo Steam-Gauge and Lantern Co.; *Brass and Copper Piping*, Benedict and Burnham Manufacturing Co.; *Staybolts and Tank Iron*, Catasauqua Manufacturing Co,; *Jacket Iron*, W. D. Wood & Co's Patent Planished Sheet-Iron; *Head-Light*, Philadelphia Railroad Lamp Works.

RUNQVIST'S OSCILLATING GOVERNOR.

[*Swedish Section, Machinery Hall.*]



There is hardly another apparatus that appears in more various forms than that having the function of regulating the speed of steam-engines or other motors. And yet the field is far from being exhausted. But however various the forms of governors and the detailed principles of their construction, there is but one fundamental principle on which the action of all governors is founded. In any governor, two forces or two sets of forces are produced; one being dependent on the speed of the engine, the other on the position of the valve-adjusting parts of the governor; these forces acting in opposite directions. If the speed increases, the first-mentioned force overcomes the second, and an adjustment of the valve is effected; if the speed diminishes, the former falls below its adversary, and a regulation of the valve in the opposite sense is the result.

The great diversity of means for producing a force by motion readily explains the fact mentioned at the beginning. In most governors use is made of centrifugal force, acting against either gravity, or a spring, or both. In other forms, the resistance of vanes revolving in air or in liquids is made available for the purpose. It being, however, not my intention to enumerate here all means that have hitherto been employed; it may suffice to state that the principle of producing a force dependent on velocity, constituting the novel feature of the governor to be described, is quite original. It is simply frictional resistance, the pressure producing the friction being dependent on the velocity.

To the rapidly revolving main spindle of the governor is rigidly attached a bracket which carries on one side a set screw, and on the other a segment of an iron ring, C, in which are mounted three blocks of hard wood. This segment is so attached to the bracket that the faces of the three wooden blocks can readily adjust themselves to form one plane with the point of the set screw, however the latter may be adjusted. This plane is not at right angles to the revolving spindle, but is more or less inclined.

A heavy ring, B, is so attached to the body of the governor by a universal joint that it cannot revolve, but can freely oscillate. This ring is adjusted closely against the wood-blocks and set screw mentioned before; and the latter forming a plane inclined to the spindle, rotation must transmit an oscillating movement to the ring, B. This oscillation brings into play the inertia of the mass of the ring, reacting against the wood-

blocks, and producing, by friction, a resistance against the rotation of the shaft, evidently increasing with the speed.

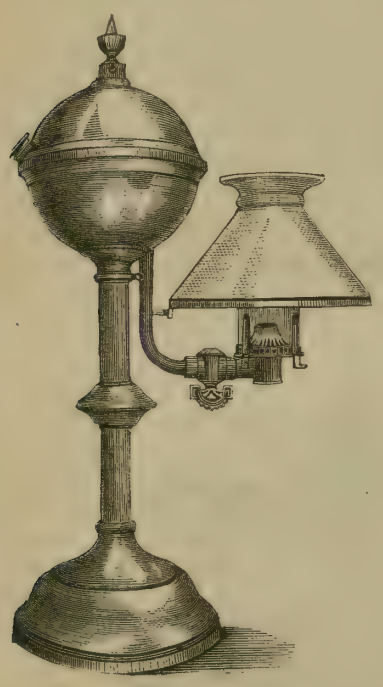
The governor is driven from the engine by the pulley, A, whence the motion is transmitted by the pinion, L, to the wheel, G, which revolves loose on the main spindle of the governor. This wheel gears into a pinion fastened to a spindle, to which the wheel, H, is keyed; and this wheel finally transmits the motion to the main spindle, by the pinion, K. The lever, F, is forked at its fulcrum, that is formed by the main spindle, and it is extended beyond this fulcrum, carrying the spindle of the wheel, H. From this it will be seen that the combination of wheels forms a differential gear; and here is where the resistance offered against the rotation of the main spindle meets its opponent—the tension of a vertical spiral spring—that will be elongated more or less according to the speed. The lever, F, carries on its front end an adjustable saddle, to which the valve rod can be attached.

HUGO BILGRAM.

[The governor described has attracted considerable attention, owing to its novelty of construction and apparent sensitiveness of operation. It is not yet attached to a motor, and hence no practical test has been made; but Prof. Angstrom and others in Stockholm, attest its synchronism. G.]

BALL'S HYDROCARBON GAS LAMP.

The accompanying engraving illustrates a form of self-generating gas lamp, which is worthy of more than passing notice, both on account of the mechanical ingenuity displayed in its details, and its admirable adaptation for practical use. The lamp is the invention of Charles E. Ball of Philadelphia, and its construction and operation will be apparent from the following description:



The body of the lamp, as shown in the engraving, consists of a hollow spherical chamber supported centrally upon a substantial pedestal. This chamber is divided into two compartments by the interposition of a horizontal septum or partition, which effectually isolates the two compartments from communication except through a central tube, or neck, open above and below, which extends downward into the lower compartment from the centre of the dividing wall. The lower compartment is designed to receive the oil, which is replenished through a lateral tube, the the neck of which, closed by a suitable cap, is seen projecting slightly from the side of the globe. The upper compartment of the chamber and the central tube or neck which extends downwards into the lower compartment, are tightly packed with cotton wick and pumice stone, thus establishing communication by capillarity between the oil in the lower compartment and the cotton wick in the upper. At the top of the globe, there is a neck through which communication with the outer air may be established or cut off entirely by turning a sliding collar, and thus opening or closing one or more ports with which the attachment is provided. From the side of the globe, finally, proceeding from the wick chamber and passing downwards through the oil compartment, extends a pipe, provided at its extremity with the ordinary accessories for consuming illuminating gas; shut-off cock, argand burner, chimney, etc.

The operation of the device will be understood from what follows:

The cotton wick in the upper chamber is kept constantly and moderately moist with oil drawn by capillary attraction from the oil reservoir.

To start the lamp in operation, the access of the air must be allowed by properly turning the collar at the top of the globe. This permits of the immediate establishment of a current of vapor which descends the tube in virtue of its superior gravity, and finds its way to the burner, where it may be ignited. Then the operation proper sets in.

The ascending, heated and rarified combustion products, by difference of atmospheric pressure, induce the entrance of an air current through the ports at the top of the globe, which air, in its passage through the oil-charged mass of cotton wick, loads itself to saturation with the light-giving vapors, passes thence down the service pipe to the burner and is there consumed. The operation of the lamp is, therefore, practically automatic. The size of the flame will remain constant for a long time, and only after several hours of constant use, will require regulation, which is instantly done by turning the collar above, so as to regulate the air supply.

The extreme sensitiveness of the flame in relation to the air supply, is remarkable, and will excite the surprise and admiration of every beholder. Let the collar be turned never so slightly and the flame at once responds by increasing or diminishing, as the case may be. The regulation of the size of the flame may therefore be effected to a nicety by the adjustment of the collar, and once adjusted, it remains practically constant for a considerable time, and the light itself, as regards brilliancy, steadiness and entire absence of smoke, is all that could be wished.

It is obvious that the same principles of construction may be applied to lamps varying very much in their external appearance from the one herewith illustrated, which shows it in its simplest form. It may, for instance, take the form of a chandelier, in which the globe is centrally located and is made to feed a number of burners arranged concentrically about it; or, instead of one reservoir for the oil and wick, divided into two compartments by a partition, two separate chambers may be employed, etc.

The mechanical construction of this device, as will have been observed from the foregoing comments, is most ingenious, the lamp making its own gas, continuously and automatically, without the introduction of machinery or clock work, and without the use of a wick. We may safely affirm it to be decidedly the best representative of its class that has been brought to our notice.

W.

THE MECHANICAL ACTION OF LIGHT.*

A Lecture delivered at the Royal Institution February 11th, 1876.

By W. CROOKES, F. R. S..

To generate motion has been found a characteristic common, with one exception, to all the phases of physical force. We hold the bulb of a thermometer in our hands, and the mercury expands in bulk, and, rising along the scale, indicates the increase of heat it has received. We heat water, and it is converted into steam, and moves our machinery, our carriages, and our ironclads. We bring a loadstone near a number of iron filings, and they move towards it, arranging themselves in peculiar and intricate lines; or we bring a piece of iron near a magnetic needle, and we find it turned away from its ordinary position. We rub a piece of glass with silk, thus throwing it into a state of electrical excitement, and we find that bits of paper or thread fly towards it, and are, in a few moments, repelled again. If we remove the supports from a mass of matter it falls, the influence of gravitation being here most plainly expressed in motion, as shown in clocks and water-mills. If we fix pieces of paper upon a stretched string, and then sound a musical note near it, we find certain of the papers projected from their places. Latterly the so-called "sensitive flames," which are violently agitated by certain musical notes, have become well known as instances of the conversion of sound into motion. How readily chemical force undergoes the same transformation is manifested in such catastrophes as those of Bremerhaven, in the recent deplorable coal-mine explosions, and indeed in every discharge of a gun

But light, in some respects the highest of the powers of Nature, has not been hitherto found capable of direct conversion into motion, and such an exception cannot but be regarded as a singular anomaly.

This anomaly the researches which I am about to bring before you have now removed; and, like the other forms of force, light is found to be capable of direct conversion into motion, and of being—like heat, electricity, magnetism, sound, gravitation and chemical action—most delicately and accurately measured by the amount of motion thus produced.

My research arose from the study of an anomaly.

It is well known to scientific men that bodies appear to weigh less when they are hot than when they are cold; the explanation given being that the ascending currents of hot air buoy up the body, so to speak. Wishing to get rid of this and other interfering actions of the air during a research on the atomic weight of thallium, I had a balance constructed in which I could weigh in a vacuum. I still, indeed, found my apparatus less heavy when hot than when cold. The obvious explanations were evidently not the true ones; *obvious* explanations seldom are true ones, for simplicity is not a characteristic of Nature.

An unknown disturbing cause was interfering, and the endeavor to find the clue to the apparent anomaly has led to the discovery of the mechanical action of light.

I was long troubled by the apparent lawlessness of the actions I obtained. By gradually increasing the delicacy of my apparatus I could easily get certain results of motion when hot bodies were brought near them, but sometimes it was one of attraction, at others of repulsion, whilst occasionally no movement whatever was produced.

I will try to reproduce these phenomena in this apparatus (Fig. 1). Here are two glass bulbs, each containing a bar of pith about three inches long, and a half an inch thick, suspended horizontally by a long fibre of cocoon silk. I bring a hot glass rod, or a candle, towards one of them, and you see that the pith is gradually attracted, following the candle as I move it round the bulb. That seems a very definite fact; but look at the action in the other bulb. I bring the candle, or a hot glass rod, near the other bar of pith, and it is strongly *repelled* by it—much more strongly than it was attracted in the first instance.

FIG. 1.

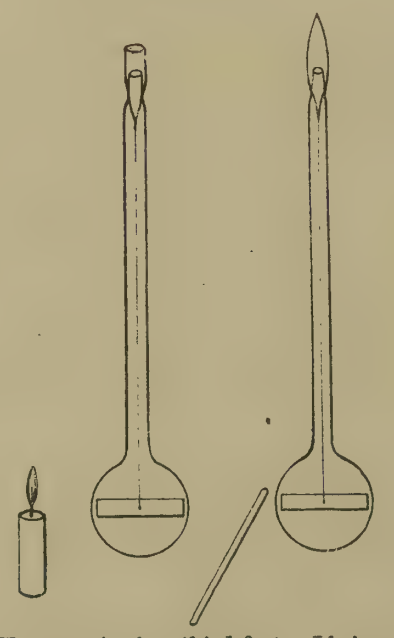
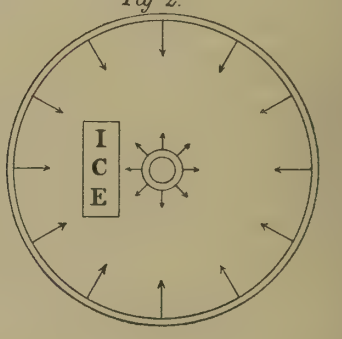


Fig 2.



Here, again, is a third fact. I bring a piece of ice near the pith bar which has just been repelled by the hot rod, and it is attracted, and follows the rod round as a magnetic needle follows a piece of iron.

The repulsion by radiation is the key-note of these researches. The movement of a small bar of pith is not very distinct, except to those near, and I wish to make this repulsion evident to all. I have therefore arranged a piece of apparatus by which it can be seen by all present. I will, by means of the electric light, project an image of a pendulum suspended *in vacuo* on the screen. You see that the approach of a candle gives the bob a veritable push, and, by alternately obscuring and uncovering the light, I can make the pendulum beat time to my movements.

What, then, is the cause of the contradictory action in these two bulbs—attraction

* [For the engravings illustrating this paper we are indebted to the courtesy of the authors.—EDS]

in one, and repulsion in the other? It can be explained in a few words. Attraction takes place when air is present, and repulsion when air is absent.

Neutrality, or no movement, is produced when the vacuum is insufficient. A minute trace of air in the apparatus interferes most materially with the repulsion, and for a long time I was unaware of the powerful action produced by radiation in a "perfect" vacuum.

It is not at first sight obvious how ice or a cold body can produce the opposite effect to heat. The law of exchanges, however, explains this perfectly. The pith bar and the whole of the surrounding bodies are incessantly exchanging heat-rays; and under ordinary circumstanees the income and expenditure of heat are in equilibrium. Let me draw your attention to the diagram (Fig 2) illustrating what takes place when I bring a piece of ice near the apparatus. The centre circle represents my piece of pith; the arrows show the influx and efflux of heat. A piece of ice brought near cuts off the influx of heat from one side, and therefore allows an excess of heat to fall on the pith from the opposite side. Attraction by a cold body is therefore seen to be only repulsion by the radiation from the opposite side of the room.

The latter developements of this research have demanded the utmost refinement of apparatus. Everything has to be conducted in glass vessels, and these must be blown together till they make one piece, for none but fused joints are admissible. In an investigation depending for its successful prosecution on manipulative dexterity, I have been fortunate in having the assistance of my friend Mr. Charles Gimingham. All the apparatus you see before you are the fruits of his skillful manipulation, and I now want to draw your attention to what I think is a masterpiece of glass-working—the pump which enables me so readily to produce a vacuum unattainable by ordinary means.

[*To be Continued*]

FIRE PROTECTION.

CONCERNING SPONTANEOUS COMBUSTION.

II.

It is in most cases a matter of extreme difficulty, demanding the exercise of close investigation and of excellent judgment, to determine the cause of a fire. This difficulty, it is almost needless to state, is inseparably associated with the nature of the occurrence; for not only does the destructive agent frequently extinguish in its progress every trace of its origin, but in this feature, its efforts are uniformly reinforced by the radical measures that must be employed to annihilate it. In addition, likewise, to the natural difficulties of the situation, the investigator is not infrequently beset with suggestions of an array of ingenious but mysterious possibilities, with which this subject is even more richly endowed than the vexatious conundrum of steam boiler explosions. In this connection, reference is made, amongst other things, to the large number of occurrences to which the name of spontaneous combustion is popularly given, and to which, from their relation to commercial and manufacturing interests, an unusual share of interest attaches. That this interest has not been overestimated is very manifest from the fact which is generally well known, that spontaneous combustion affords a convenient explanation for any and every fire or conflagration where the origin of the disaster cannot be clearly traced to another source. It is, therefore, a factor that enters importantly into the business relations of insurers and insured; and the clearest knowledge of its possible influence in originating fires, under the varied conditions and circumstances of business, is indispensable in order that the financial relations of the two great interests involved may be established upon an equitable basis. Such a degree of familiarity with the genesis and causation of the so-called spontaneous fires as shall permit, on the one hand, of the adoption in each particular instance of proper preventive and precautionary measures to reduce the danger to a minimum; and, on the other hand, of a just estimation of the amount of risk incurred, which shall be satisfactory and equitable to both parties, is greatly to be desired; and although such conditions are by no means impossible to establish, they have thus far not been realized. Nor is it probable that such satisfactory relations will ever be established, unless as the result of the laborious and conscientious investigation of the more important phenomena, here alluded to, by competent scientific talent, selected by the joint action of both interests. In many other cases, likewise, the utility of such an unbiassed tribunal—that could readily be selected in any intelligent community and could reasonably be relied upon to give an *ex parte* verdict—would be very great, and might often realize, to the mutual advantage of antagonized interests, the value of the proverb, that "an ounce of prevention's worth a pound of cure."

We propose, in what follows, to remove from the catalogue of mysteries the occurrences generally known by the name of spontaneous combustion, by assigning their origin to natural and readily comprehensible causes, by classifying them into groups according to the several modes of their occurrence, and by establishing upon a scientific basis the few but very simple rules that have been found to be effectual in their prevention.

As a preliminary to any scientific treatment of the highly complex question of accidental fires and their origin, a knowledge of the igniting temperatures of various substances is a matter of prime importance. This factor, as everyone knows who is at all conversant with the subject, has a different value for different substances, though it is constant for each. Important, however, as a knowledge of this factor manifestly is, there are few, even amongst the best informed, who are able to state its value save for a very limited number of common substances; and this state of affairs is to be ascribed not so much to any peculiar difficulties surrounding the experimental investigation of the problem, as the fact that those whose material interests are most directly concerned in its solution have failed to adequately appreciate its peculiar importance and make known their needs. Careful investigators have established and tabulated a great variety of physical constants. We have at command very complete tables of the melting points of solids, the boiling points of liquids, specific heats and specific gravities, the temperatures of flames, the heat units developed in the burning of various fuels and other standard values *ad libitum;* but thus far there have been comparatively few determinations of the temperatures of ignition. The paucity of information upon this vital subject will be very apparent to one who undertakes the task of searching for it in the several encyclopædias. The following tabulated information, in view of the facts just stated, will be of some utility to those who are interested in our theme.

Table showing the Temperatures required for the Ignition of Different Combustible Substances.

SUBSTANCE.	TEMP. OF IGNITION, FAHR.	REMARKS.
Phosphorus (com)	140°	Melts at 111°
Carbon di sulphide vapor	300°	Boils at 113°
Fulminating Powder	374°	Used in Percussion Caps.
Fulminate of Mercury	392°	Determined by MM. Leygue and Champion.
Chlorate of Potassa and Sulphur; equal parts	395°	
Sulphur	400°	Melts at 232°; boils at 750°
Gun Cotton	428°	Determined by MM. Leygue and Champion.
Nitro-Glycerin	494°	
Phosphorus (red)	500°	Melts at 482°; does not ignite by friction.
Rifle Powder	550°	Determined by MM. Leygue and Champion.
Gunpowder (coarse)	563°	" " "
Picrate of Mercury, Lead or Iron	565°	" " "
Picrate Powder for Torpedoes	570°	" " "
" " Muskets	576°	" " "
Charcoal, the most inflammable; used for Gunpowder	580°	Determined by M. M. Pelouze and Fremy.
Charcoal made by distilling wood at 500°	660°	" " "
Charcoal made by distilling wood at 600°	700°	" " "
Picrate Powder for Cannon	716°	
Very Dry Wood, (pine)	800°	
" " (oak)	900°	
Hydrogen	930°	
Charcoal, made at 800°	950°	
" " 1800°	1100°	
" " 2400°	1400°	
Diamond	about 1830°	
Graphite	above 2000°	
Aluminium	about 1850°	
Iron	" 2000°	

An inspection of the figures above given, discloses one fact at least, that has an important bearing upon the origin of accidental fires; namely: that to ignite even the most combustible—and therefore most dangerous—substances by heat alone, requires a considerable temperature, and one that in the vast majority of cases will not be reached save by the direct contact of a flame or spark to some portion of their mass. The relation of these facts to the causation of accidental fires, and in particular to that portion that are to be classed as spontaneous in their origin, will shortly appear.

The following essay at a classification of the phenomena last named, while it may not be either perfectly accurate or comprehensive, will at least serve the purpose of establishing a systematic view of their relations. Taking the broadest view of the subject, it may be assumed that spontaneous fires—that is to say, the taking fire of substances by the evolution of heat through the chemical activity of their own elements, without contact of the burning objects with flame, spark, or heated combustion products, and without human intervention—may originate as follows:—

First.—By the accidental contact of two or more substances, that possess the quality of acting chemically upon each other.

Second.—By the slow combustion (eremacausis) of porous substances, such as lampblack, charcoal, powder, coal, and especially of masses of wool, tow, cotton or rags when saturated with various oils or grease.

Third.—By the spontaneous ignition of explosive and other compounds.

Spontaneous fires originating from the first cause are of rare occurrence, for which reason but little importance attaches to it; nevertheless, it is safe to assert that its influence is not adequately appreciated, and that it may reasonably be held responsible for many fires, of which the origin has been called mysterious. From the nature of the case, it may be inferred that most accidents of this character will be confined to the lecture-room or laboratory of the chemist, or to the workshop of the manufacturer of fireworks and chemicals. A few cases in point are given. Spontaneous combustion of this kind can readily be illustrated by permitting a drop of strong sulphuric acid to fall upon a mixture of chlorate of potassa and white sugar, or upon caustic baryta, or a drop of water on a fresh surface of metallic potassium, or a mixture of strong nitric and sulphuric acids on turpentine, or by contact of phosphorus and chlorate of potassa, or by the evaporation of a solution of phosphorus in bi-sulphide of carbon or other volatile solvent. In each of these cases, and many more that could be enumerated, the effect produced is quite striking.

An instance of a veritable fire originating in this way, but fortunately discovered in time to prevent serious danger, is worth recording. The scene of the occurrence was the Girard College, at Philadelphia, and the then professor of Chemistry is the voucher for the details.* The class-room was found one morning to be filled with smoke, and upon searching for the cause, it was traced to an adjoining library, where it was pouring forth in volumes from the cracks in the door of a large closet. This was at once forced open, and after the burning contents had been extinguished with water, it was found that a quantity of fireworks intended for a Fourth of July celebration, had exploded during the night, nearly blowing out the panels of the door, besides setting fire to books, papers and the like. A critical examination into the cause of the accident showed that it had been brought about by the fireworks having come into contact with the contents of several broken bottles of turpentine, and sundry photographic chemicals, the relics of old experiments that had been stowed away in the closet and had escaped attention. The account from which the foregoing facts are drawn, goes on to state that if the college had not been built entirely of stone, even to the floors and arched ceilings—the closets being recesses in the heavy stone walls—the entire building might, on that occasion, have been destroyed, a conclusion that, in the light of the circumstances, seems not improbable.

Other cases, illustrative of this class of accidents, will doubtless occur to many. The one just detailed, however, is sufficient for our purpose, demonstrating as it does, that they cannot be ignored in considering the subject of spontaneous fires. The probabilities, however, of the causation of fires from this class of accidents, are confined to very narrow limits, and the precautions to be taken to guard against them are too obvious to need to be detailed.

W.

*Manufacturer and Builder, iii., 128.

(*To be continued.*)

PROGRESS IN SCIENCE AND THE ARTS.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

CHAMBERS' ARCHIMEDEAN BRICK-MAKING MACHINE.

[This apparatus was exhibited in working model form at a recent meeting of the Franklin Institute; but this description, with the report of that meeting, was crowded out of our columns. The model may be seen working in Machinery Hall, column D. 23.]

Description of Chambers, Brother & Co.'s Archimedean Brick-making Machine.—This machine belongs to the class known as "*tempered-clay machines*," or "clay-tempering brick-making machines." It is claimed that it *tempers its own clay with water*, taking the clay as it comes from the bank, without any *previous handling or preparation*, and

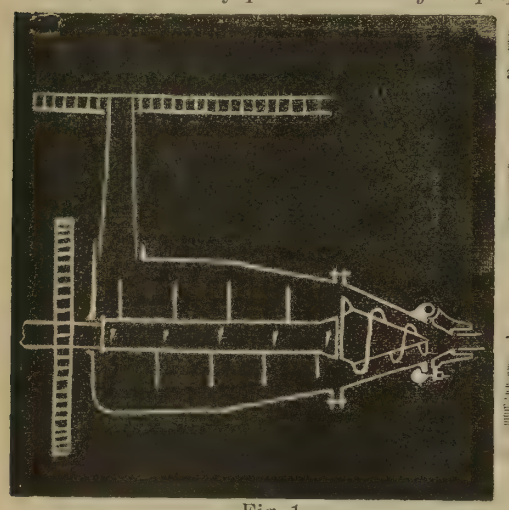


Fig. 1.

Chambers, Bro. & Co's Archimedean Brick Machine, Philadelphia, Pa.

forms it into bricks, with well-defined corners, and smooth, straight surfaces, at the rate of from fifty to eighty per minute, or from twenty-five to thirty-five thousand per day of ten hours.

Fig. 2.

Fig. 1 gives a longitudinal vertical section of the tempering and forming portion of the machine.

The crude clay is fed through a hopper (slightly larger at the bottom than at the top, to prevent packing), into the tempering portion of the machine. This consists of a strong iron case, in which revolves a horizontal shaft, into which are set spirally, strong tempering knives, or blades of steel, so that, as they pass through the clay, they move it forward. The clay being stiff, and not having much water on it, it is not liable to *slip* before the knives, but is cut through and through, and *thoroughly* mixed; so that by the time it reaches the small end of the tempering case it is ready to be formed into bricks. Fig. 2 is a transverse section through the hopper and temperer.

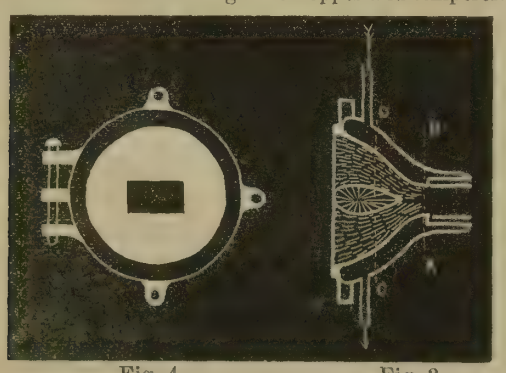


Fig. 4.

Fig. 3.

On the end of the tempering shaft is secured a conical screw, which revolves in a cast-iron conical case, the inside of which is ribbed, so as to prevent the clay from revolving in it, and is chilled, to prevent wearing.

The screw being *smooth* and very hard, the clay slides on it, thus becoming, as it were, a *nut*; the screw revolving, and not being allowed to move backward, the clay *must* go forward, and is forced in a continuous bar through the forming die, which has an orifice corresponding to the transverse section of a brick.

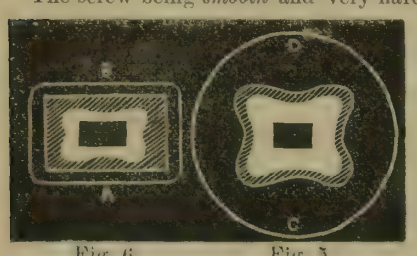


Fig. 6.

Fig. 5.

This bar, as it issues from the die, is conducted by a plate to the cutting device, which consists of a thin blade of steel, secured to the periphery of a wheel, in the form of a spiral, the distance between the blades or threads of the spiral being the exact length of a brick.

The spiral knife runs perpendicularly in a flat endless chain, which supports the bar of clay at one edge and at the bottom, or as to insure smooth square cutting and unbroken angles.

The pitch of the spiral knife insures equality in length; the drawing cut insures smooth cutting.

In order that the spiral cutter should not be affected by stones, the wheel to which it is secured is held in position by a spring which holds it with *just sufficient force to compel the knife to pass through the bar of clay*. When the knife comes in contact with any hard foreign substances, as sticks, stones, brickbats, or bones, the spring yields and allows the knife to move back, and thus cuts around it, the knife immediately flying back to its original position, ready to cut through the bar again.

An ingenious "governor" is designed to make the speed of the spiral knife depend upon the stiffness and speed of the issuing bar of clay.

The bricks, thus cut from the continuous bar, are separated and carried by an endless belt through the dusting or sanding machine, which consists of a chamber, into which is thrown, by centrifugal force or a blast of air, a continuous cloud of dust or fine sand, designed to adhere to the surface of the bricks, to render them much nicer to handle, prevent them from sticking together on the barrows or in the hacks, and improve them in color when burnt.

The die is of peculiarly ingenious construction. A common fault of the "continuous bar" machines is, that the edges corresponding to the corners of the die, were not sharp and hard as they should be. To overcome this difficulty, Mr. Chambers has given the die a peculiar enlargement in the corners, at its commencement, so that the material under compression shall be *facilitated* in finding the corners. Having thus at first placed in the corners an excess of clay, with a minimum of friction in flow, Mr. C., by a gradual contraction of the die at these corners, brings the bar out with hard and sharp edges; and claims that he can make, if desired, bricks which are much harder at the edges than elsewhere.

Fig. 3 shows a longitudinal vertical section of the former and die; Fig. 4 is an end view of the same; Fig. 5, a section through C. D.; and Fig. 6, a section through A. B.

As the tempering knife runs six inches from the case, a stone five inches in diameter will not lodge there.

A stone over three inches in diameter will lodge at the entrance of the screw and compel the flow of clay to issue at the *safety* valve. A stone of two to three inches will lodge in the forming die and split the bar; the die can be instantly swung open for its removal.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

The 197th meeting of the Society of Arts, May 25th.

FORM OF EMBANKMENTS.

Mr. Jonathan Preston made a communication, illustrated by a model, showing the form that embankments and sustaining walls should assume to support pressure agaiast them.

Many experiments in the newly-filled portions of the city, satisfied him that the fault in making such walls was in improper shape and bad disposition of too heavy materials, too much weight being toward the top and too little at the bottom. He makes on the sustaining surface a regular slope of about 45°, which he finds will sustain the greatest weight with the least amount of material.

RESEARCHES IN TELEPHONY.

Professor A. Graham Bell read a paper, illustrated by successful experiments, on "telephony," or the telegraphing of musical sounds—from which the following are extracts.

An electro-magnet gives forth a sound when suddenly magnetized or demagnetized. When the circuit is rapidly made and broken, a succession of explosive noises proceeds from the magnet, producing a musical note, when the current is interrupted a sufficient number of times per second. The discovery of "galvanic music" by Page, in 1837, led inquirers in different parts of the world, almost simultaneously, into telephonic research.

In the autumn of 1874, Professor Bell discovered that the sounds emitted by an electro-magnet under the influence of a discontinuous current are not due wholly to sudden changes in the magnetic condition of the iron core, but that a portion of the effect results from vibrations in the insulated copper wires composing the coils. An electro-magnet was arranged upon a circuit with an instrument for interrupting the current—the rheotome being placed in a distant room to avoid interference with the experiment. Upon applying the ear to the magnet a musical note was clearly perceived, and the sound persisted after the iron core had been removed, though of feebler intensity, and accompanied by the usual crackling sound.

When a spiral of fine wire is made to dip into a cup of mercury so as thereby to close a galvanic circuit, the spiral coils up and shortens. Ferguson constructed a rheotome on this principle. Professor Bell believes that a somewhat similar motion is occasioned in a helix of wire by the passage of a discontinuous current, but that other causes conspire to produce the sounds referred to; such as the extra currents occasioned by the induction of the voltaic current upon itself in the coils of the helix, and molecular vibration in the conducting wire. Sounds proceed from conductors of all kinds when formed into spirals or helices. These sounds in some cases are so faint that extreme quietness is necessary for their perception. The rheotome itself is a great source of annoyance, as it always produces a sound of similar pitch to the one which it is desired to hear, and must be placed at such a distance, out of ear shot, as to exclude the possibility of sounds being mechanically conducted along the wire.

Very striking effects can be produced upon a short circuit by means of two Grove elements. He had a helix of insulated copper wire (No. 23), having a resistance of about twelve ohms. It was placed in circuit with a rheotome interrupting the current one hundred times per second. Upon placing the helix to his ear he could hear the unison of the note produced by the rheotome. The intensity of the sound was much increased by placing a wrought-iron nail inside the helix, accompanied by a crackling sound when any portion of it touched the helix.

Loud sounds are emitted by pieces of iron and steel when subjected to the attraction of an electro-magnet placed in circuit with a rheotome; the armatures of Morse sounders and relays produce sonorous effects. He rendered the sounds of an organ in a distant room audible to the audience by the interposition of a tense membrane between the electro-magnet and its armature. The armature consisted of a piece of clock spring glued to the membrane, a form of apparatus which he has found invaluable. The reeds of the organ were so arranged as to open and close the circuit during their vibration, and when the instrument was played the music was loudly reproduced by the telephonic receiver on the table before him. When chords were played, their various notes were emitted simultaneously by the armature of the receiver.

He foresaw the simultaneous production of musical notes of different pitch by the electric current in 1870, and demonstrated it in 1873; Elisha Gray of Chicago, and Paul de la Cour of Copenhagen, lay claim to the same discovery. The fact that sounds of different pitch can be simultaneously produced upon any part of a telegraphic circuit is of great practical importance, for the duration of a musical note can be made to signify the dot or dash of the Morse alphabet, and thus a number of telegraphic messages may be sent simultaneously over the same wire without confusion, by making signals of a definite pitch for each message.

If the armature of an electro-magnet has a definite rate of oscillation of its own, it is thrown bodily into vibration when the interruptions of the current are timed to its movements.

When two persons receive a shock from a Ruhmkorff coil by clasping hands, each taking hold of one wire of the coil with the free hand, a sound proceeds from the clasped hands. The effect is not produced when the hands are moist. When either of the two touches the body of the other, a loud sound comes from the parts in contact; when the arm of one is placed against the arm of the other, the noise produced can

be heard several feet. In all these cases a slight shock is experienced so long as the contact is preserved. The introduction of a piece of paper between the parts in contact does not materially interfere with the production of the sound, while the unpleasant effects of the shock are avoided. When a powerful current is passed through the body, a musical note can be perceived when the ear is closely applied to the arm of the person experimented upon.

When a voltaic battery is common to two closed circuits, the current is divided between them. If one of the circuits is rapidly made and broken, a pulsatory action of the current is occasioned upon the other. All the audible effects resulting from the passage of an intermittent current can also be produced, though in less degree, by means of a pulsatory current.

When a permanent magnet is caused to vibrate in front of the pole of an electro-magnet, sounds proceed from the armatures of other electro-magnets placed upon the same circuit. The telephonic receiver was connected in circuit with a single-pole electro-magnet—no battery being used. A steel tuning-fork (previously magnetized) was caused to vibrate in front of the pole of the electro-magnet; a musical note similar in pitch to that produced by the tuning-fork was perfectly audible from the receiver in a distant room. The effect was much increased when a battery was included in the circuit.

Two single-pole electro-magnets, each having a resistance of ten ohms, were arranged upon circuit with a battery of five carbon elements; the total resistance of the circuit was about twenty-five ohms. A drumhead of goldbeater's skin, seven centimetres in diameter, was placed in front of each electro-magnet, and a circular piece of clock spring, one centimetre in diameter, was glued to the middle of each membrane. One of these telephones was kept in the experimental room, and the other placed in the basement of an adjoining house. Upon singing into the telephone, the sounds of the voice were reproduced by the instrument in the distant room. When two persons sang simultaneously into the telephone, the two notes were audible from the other instrument.

A friend was sent into the adjoining building to note the effect produced by articulate speech. Professor Bell placed the membrane of the telephone near his mouth, and articulated the sentence, "Do you understand what I say?" Presently an answer came back through the instrument in his hand; articulate sounds proceeded from the clock spring attached to the membrane, and he heard the words, "Yes, I understand you perfectly."

The articulation was somewhat muffled and indistinct, but in this case intelligible. Several familiar quotations were readily understood after a few repetitions. A critical analysis of the effects produced leads to the belief that the vowel sounds alone are faithfully reproduced; diphthongal sounds and large aperture vowels are readily discriminated; consonants are unrecognizable. Occasionally, however, a sentence would come out with startling distinctness, consonants as well as vowels being audible.

In conclusion, he stated that telephonic effects can be produced by three distinct varieties of currents—1, intermittent; 2, pulsatory, and 3, undulatory. Intermittent currents are characterized by the alternate presence and absence of electricity upon the circuit. Pulsatory currents are produced by sudden changes in the intensity. Undulatory currents result from gradual changes, analagous to the changes in the density of air occasioned by pendulous vibrations. These he represented on the blackboard, graphically.

CENTENNIAL NOTES.

The Gregg Impact Brick Machine Company of this city, exhibits in Avenue No. 3, Machinery Hall, samples of pressed bricks, stretchers, back stretchers, and salmon bricks, made by the machine named—a full and illustrated description of which appeared in Vol. I of this journal, pages 30 and 31.

The Philadelphia Shafting Works of Mr. George V. Cresson, have an attractive and characteristic display of shafting, pulleys, internal clamp coupling, hangers, balanced pulleys, etc., full description of which is postponed to permit of accompanying it with a cut. The very ingenious mode which Mr. Cresson has adopted to *compel*, as it were, the attention and inspection of visitors will no doubt meet with imitation at the many coming local and other Industrial Exhibitions. The framework familiar as Mr. Cresson's at the Frankin Institute Exhibition of 1874, again greets the eye; but the pulleys are revolving in a very quiet and ludicrous way, by frictional contact. Mr. Cresson's Driving Coupling, with internal clamp hub, which gives a perfect fit on the shaft, without forcing or sledging, have a grip to which even the Rev. W. H. H. Murray's is child's play.

CORNELL UNIVERSITY.

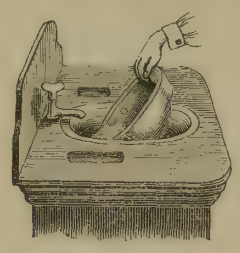
The department of mechanical engineering of Cornell University, Ithaca, N. Y., is represented in Machinery Hall (B. 68) by several very creditable specimens of the handiwork of the students. Among these we may mention the following: The amateurs' lathe, a high-speed horizontal engine, a Gramme dynamo-electric machine (of which there are probably not over half a dozen in this country), a "contact" measuring machine, showing ten-thousandths of an inch from zero up to twelve inches; standard scraped surface plates, rivalling the Whitworth planimeters.

These tools, together with many others, are made by the students of Cornell, in addition to their regular studies (the requirement in this department being ten hours' work per week), and under the immediate supervision of Prof. Sweet, whose writings in scientific journals are well and favorably known.

It it is safe to assume that students under special instruction in a mechanical department, will make greater advancement than if apprenticed at once to a regular machinist of the average amount of information; as all questions occurring to an inquiring mind can be referred to and explained by an instructor, who takes an interest in, and especially prides himself upon, the advancement of those under his charge. Pupils get a general knowledge covering the whole ground, while they become proficient in such special branches as will be most advantageous to them in the future. (Reference need be made only to the instruments and tools in the Cornell exhibit, to prove the point of proficiency and accuracy).

The students are not left to pick up knowledge as best they can, nor are they confined to a certain class of work longer than is necessary to a practical knowledge of that particular class.

The general enthusiasm which prevails in schools of a high character leads students, who have any pride, to exert themselves to the utmost that they may not be excelled by their classmates, nor by their obtaining partial knowledge only. Under this salutary influence is developed perseverance, energy, self-reliance, and a commendable zeal which fits the students to battle and succeed in the strife of maturer years.



Jennings' "Tip Up" Wash Basin.—A very neat contrivance is shown in the Franklin Institute Reception Room, Machinery Hall—the Jennings' Tip Up Wash Basin, shown in the cut. The water in this stationary wash-stand basin can be emptied instantly; there is no plug to lose or to grope after.

MISCELLANEOUS.

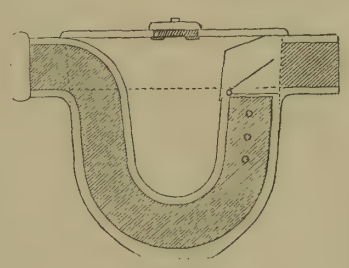


Fig. 1.

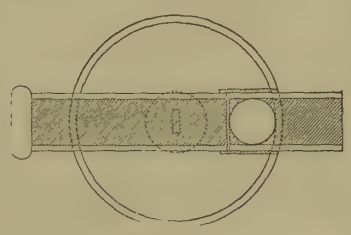


Fig. 2.

Bedell's Terra Cotta, Non-Syphoning, Self-Cleansing, Sewer Gas Trap and Water Tank is the rather lengthy title of a contrivance shown herewith, and claimed to afford a perfect trap, through which no rats can enter the drain to gnaw lead pipes, etc.; that no odors can back up through it; and that it may be put in any drain in ten minutes' time. The patentee's circular does not describe it clearly. Fig. 1 shows a longitudinal vertical section; Fig. 2, a section through dotted line.

Submarine Telegraphy.—From 1850 to the end of 1874, the number of telegraphic cables actually submerged was 206, representing a length of 80,000 kilometres (about 49,000 miles). Of these 206 cables sixty-one have ceased to be of any use, and 145 are still working. England and France are the two countries which possesses the most submarine cables. England has twenty-nine and France sixteen. France and England are themselves bound together by seven telegraph cables.

In 1850 and 1851 but two submarine cables were laid down. This magnificent enterprise was then in its infancy. In 1852 and 1853 eight cables were immerged, in 1854 seven, in 1855 nine, in 1856 and 1857 one each year, in 1858 five, in 1859 thirteen, in 1860 twelve, in 1861 one, in 1862 two, in 1863 one, in 1864 six, in 1865 three, in 1866 ten, in 1867 seven, in 1868 two, in 1869 seventeen, in 1870 twenty-seven, in 1871 twenty-six, in 1873 fourteen, and in 1874 thirteen.

Among the longest of these submarine cables, is that which runs from Ireland to the American coast of Newfoundland, which measures 1920 miles; the cable from Ireland to the coast of St. Vincent at Pernambuco measures about 1950 miles, and that from Brest to St. Pierre about 2570 miles. France, therefore, has laid beneath the sea the longest cable known.

The greatest depth of immersion of cables is as follows: The cable between Malta and Alexandria lies at a depth of 13,800 feet; that between Ireland and Newfoundland, 17,700 feet; that between Portkarno, in England, and Lisbon, 18,000 feet; that between Brest and St. Pierre, 11,370 feet. Before 1851, the era when the first transatlantic cable was laid, no cable of a greater length than 350 miles was in existence. After having been in use but a month, the first transatlantic cable broke. This was a serious check; but it had been proved that the ocean could be spanned by an electric wire.

The conception of the project of a trans-oceanic telegraph is due to an ingenious American, Mr. Cyrus W. Field, to whom, in 1864, the Congress of the United States gave a vote of thanks and a gold medal. He also obtained the *"grand prix"* at the International Exposition of Paris in 1867.

It was not until 1870 and 1871 that direct communications were established between England, India, China, Japan and Australia. At present it only needs to lay a cable at the bottom of the Pacific Ocean in order to surround the world with a complete *ceinture* of electric telegraphy, according to the dream of Mr. Cyrus Field. The total length of the Pacific cable would be about 5540 miles, divided into three sections—First, from San Francisco to Honolulu, 2087 miles; Honolulu to Midway Island, 1164 miles; from the last-mentioned to Yokohama, 2289 miles.

Eleven new cables are at the present writing in course of construction, having a total length of 17,000 miles. The largest ones will connect Ireland and New Caledonia, 2188 miles; Aden and the Mauritius, 2777 miles; and Honolulu and the Fiji Islands, 2876 miles. The strength and endurance of submarine cables depends upon the depths to which they are submerged and the nature of the ocean bottom upon which they rest. If there are rapid currents and a rocky bottom, the cable must be made very solid and heavy. The cables of the Anglo-American Company cost 5000 francs per kilometre (.62 of a mile) for those which lie in the depths of the ocean, but those for nearer shore cost 16000 francs per kilometre. The cables between England and Holland are constructed almost through their entire length on the model of the in-shore transatlantic cables, because the water the whole distance is comparatively shallow, and never exceeds thirty fathoms. Of course, their cost was heavy.

There are sixteen companies of submarine telegraphy, with a capital of upwards of 500,000,000f. The principal is the Anglo-American Company, which possesses five cables and a capital of 175,000,000f. The Eastern Submarine Telegraph Company has a capital of 75,000,000f. The West India and Panama Company has a capital of 47,500,000f. The Eastern Extension, Australia and China, has a capital of 41,500,000f. The Western and Brazilian has a capital of 33,500,000f.

There can be little doubt that the tendency of the times is to the unification of the telegraphs under the governments of the respective countries wherein they are located. The vast extension of telegraph cables leads to the expectation that a still further consolidation of interests will be effected, and the telegraphs of the world will finally be placed under the control of an international commission. [*From L'Electricité.*]

The Scientific American Supplement (No. 23, June 3, p. 353) quotes uncorrected from *The Carriage Monthly*, that "water mixed with *sodium* and ferrocyanide of potassium will carbonize to a fair extent, any iron sufficiently hot, when plunged, to attract and absorb the sodium and potash.

Registering Barometer.—Mr. Wm. A. Barnes, of Bridgeport, Conn., proposes in the *Scientific American* of May 13, p. 308, a registering barometer very much resembling the (Swedish) apparatus of A. G. Theorell, shown at the London Exposition of 1871, described in the Acts of the Royal Swedish Academy of Sciences for 1872, and now, as improved by Mr. P. M. Sörensen, exhibited in the Swedish School House at the Centennial. This latter apparatus we shall describe in either this number or our next.

Do Bees Gather Honey?—Prof. C. V. Riley denies it (Dr. Watt to the contrary notwithstanding), and asserts that they *make* it, by semi-digestion and excretion.

BIBLIOGRAPHICAL NOTICE.

HAND-BOOK OF MODERN STEAM FIRE ENGINES; including the Running, Care and Management of Steam Fire Engines and Fire Pumps, with illustrations. By Stephen Roper, Engineer, author of "Roper's Catechism of High Pressure and Non-Condensing Steam Engines," etc., etc.; Philadelphia; Claxton, Remsen & Haffelfinger, 1876; 411 pp., 12mo, morocco tucks. Price, $3.50.

This work contains much valuable information, a large portion of which has never before been brought together in book-form. It is the work of an engineer who, although no trained book-maker, has a fund of practical knowledge, which, by his popular works, he places at the service of the community. Hence, we may forgive the fault of a very unsystematic arrangement of the contents, on account of the value of most of the matter in the work.

A very complete set of tables, rules, etc., is contained in the compact little volume, and adds to its permanent value.

CONCERNING SAWS.

"You never saw a saw saw as that saw saws."—*Old Saw.*

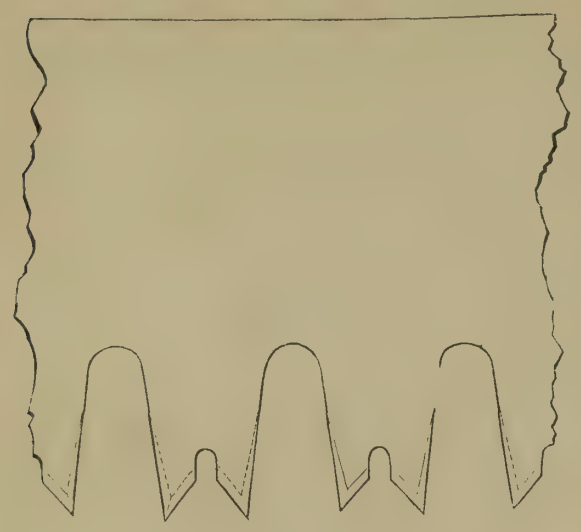


Fig. 1.

The saw is one of the most ancient and most useful of tools. The ancient Egyptians, far back in the silent centuries, formed and used this implement, the material being bronze hardened by an art now lost; but they knew it only as a *rip*-saw. The Greeks, masters of many and far-sailing wooden ships for war and exploration, deified the inventor, who comes down to us as Talus or Perdrix. The carpenter's saw of the Greeks was a straight frame, with perpendicular teeth, and two-handed. A peculiarity of the saws of all Asia, and of ancient Greece, is that they do not employ the *thrust* cut, which gives the straightest cut and the freest from sawdust—but their saws cut on the *back* stroke, or with a pulling cut. As regards this last, those of us who have smiled—perhaps even audibly—at the Japanese with their backward-working saws, should bear one thing in mind before condemning *in toto* the pulling cut:—that for keyhole (or any flexible-bladed) saws, the backward or pulling cut is the best; and our usage with that exasperating implement, the keyhole saw, is much more ludicrous and unphilosophical than the pulling cut of the Niphonese.

As observation and practice taught men better how to work in wood, the saw was made to cut more freely and bind less between the severed surfaces, by making it thinnest at the back. Later, the system of *setting* was introduced; the eastern nations bending the points of a dozen or so of adjacent teeth to one side, and those of the group to the other. Setting alternate teeth was the next wrinkle; and after the custom of swaging the teeth of saws came into use, we find inventors' brains running riot to produce the swaging tools.

But during all the centuries which witnessed the birth and rise, the haughty supremacy, and the fall of nations in successive turns, no important change was made for the better, in the manufacture of saws, until, in 1790, a device was brought out by Brunel, by which cutting should be continuous:—in other words, the application of the rotary principle to power-driven saws was given to the world. In over half a century succeeding—a half century characterized by many most remarkable inventions—no further change was made in the saw principle; and not until within a very few years were men liberated from the thraldom imposed when the pyramids were unprojected—the tax of 50 per cent. upon time, strength and purse, because of the saw cutting but one way, and in that one way tearing its way through by "main force and stupidness." Up to the year 1866 the shape of all saw teeth was that presented on the fracture of homogeneous plates of metal; and half of each double stroke of the reciprocating saw was lost—paid as a tribute to the god Ignoramus.

Since then the world has watched with an interest founded no less on selfish considerations than on admiration for genius and pluck,—the birth, growth, and rapid success of the Boynton Lightning Saw, an implement embodying in its cheap and simple construction, the first gleam of inventive genius manifested in the making and use of hand saws, since Tubal Cain, or Vulcan, forged swords and saws from primeval iron.

We have long recognized the principle that "it is a poor rule that won't work both ways." It is now convincingly brought to our minds that "it is a poor *saw* that won't work both ways."

Fig. 2.

Taking the base of the ordinary single-acting V-tooth, Mr. Boynton erects upon the same line, two teeth (see Fig. 2), or a double tooth; an M, in fact, with cutting edges fore and aft; its adjacent neighbor, alike M-shaped, and sharpened on all edges, but beveled oppositely.

This for the construction; for the operation, let the concise and keenly-advanced arguments and claims of the inventor tell the whole story.

"Any dealer is aware that in an ordinary hand saw, the front cut is the effective cut, and drawing back the saw has little effect by reason of the slant edges riding over the fibre, as the saw is drawn back. The difference between the front cut of a hand saw, and the back cut, is the difference between the Lightning saw teeth and all others; and all other saws are set one point and ride on slant edges. By setting two points of my M the same side, and the next two the other, I conceal the slant between them, and operate wholly by the outside of a nearly vertical M tooth. Standing nearly vertical the two points of the M occupy the same space as one old V-tooth. One point only is cutting and the other follows in the slit behind it to cut in the same manner, in the return motion, thus doubling the cut upon the same base and space of tooth. This construction also gives the breadth and durability of nearly an inch of steel instead of a single slender scraping point, and presents the upright instead of the slant edges to the timber. Any one can in a moment test the principle by comparing the front and back cut of any V-tooth hand saw. My new patent of March 28th, 1876, allows the sawdust perfect clearance; the arch slightly widening to the points of teeth renders it impossible for green or resinous sawdust to be retained, while the slightly increased breadth at base of tooth gives the durability so much advocated by parties who have round-edged files for sale. Slightly pyramidal, the outer edges are as upright as the front cut of a hand saw, and the back slant cut is concealed in no other saw than mine, by setting the two points of M to cut in line instead of alternately. Thus by this new patent I avoid all "overhang or under-cut," avoid all tearing, and to the matchless speed of the Lightning dress and set, add the durability, simplicity of sharpening, and sweet cutting so much admired. I thus adapt the Lightning teeth to universal use, in all hand, pruning, buck, and cross-cut saws. The concave in the centre of the M saves files, and renders it impossible to file the tooth out of shape. A 10-inch cant file and set fitting the M is furnished for forty cents, that will file ten saws easily.

"A 16-inch log was sawed off in 17 seconds, by hand, with a Lightning cross-cut saw, at Pennsylvania State Fair, on September 30th, 1874, before President Eby; W. B. Lawson, S. S. Hoagland, and other officers of the State Board, timing."

Mr. Boynton offers $1,000 challenge to any responsible maker, that will equal his saw in speed and ease of cutting.

Mr. Boynton recently sawed a 12-inch gum wood log by hand in seven seconds, before Dom Pedro, Gen. Goshorn, Col. Albert, Commissioners Morrell, Lynch and many others.

COMBINED FIRE HYDRANT AND STREET LAMP.

The cut shows a device intended to meet the requirements expressed by the National Convention of Chief Engineers of Fire Departments at the last meeting. On this occasion that body officially expressed a wish long felt by the members as individuals, for "some means of designating clearly the exact position of fire hydrants."

By combining a street-lamp with the hydrant, the exact position of the latter is very readily indicated: it will not be possible to hide the hydrant by a barrel or box, as occasionally done by the friends of a particular engine company in volunteer departments; light is afforded to make hose attachment, and to operate the engine where one is used.

The cut shows the hydrant provided with three outlets, each with a double cap, to afford attachment for either six-inch suction or ordinary leading hose.

The Committee on Science and the Arts, of the Franklin Institute, made a commendatory report upon this combination. This report is endorsed by many chief engineers and firemen throughout the country.

Application has been made for patents upon the device; and the inventor, having retired from the fire-supply business, desires to sell all rights. Address S. B. Johnson, care of this journal.

THE POTTIN PARLOR BILLIARD TABLE.

A combination, in a Handsome Centre Table, of the requisites for playing simultaneously

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THE POTTIN DINING BILLIARD TABLE.

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ROTARY PUMPS,
ROTARY STEAM
FIRE ENGINES,

HOSE AND FIRE
DEPARTMENT
SUPPLIES.

SENECA FALLS, NEW YORK.

NEARLY 600 OF THESE ENGINES IN USE.

BRYANT'S SELF-LUBRICATING CAR WHEEL

Works substantially as follows: A spiral spring running through the centre of the oil chamber, bears on its lower extremity a sponge which caps the feed orifice (see cut). The centrifugal force consequent on revolution tends to throw the oil to the upper portion of the chamber and thus prevent an excess being fed out below, while the spiral spring, acted upon by the jar and vibration and motion, forms a conductor that keeps the sponge saturated with oil and feeding a small quantity (amply sufficient for lubricating purposes.) into the orifice, whence it is drawn to fill the vacuum caused by the action of the friction surfaces, the hub and axle, upon each other.

When the wheel is at rest, the supply ceases, as the sponge pressing steadily on the mouth of the orifice prevents leakage. Small chambers on the inside of the hubs receive the surplus oil, if any, and feed it out again as required.

The oil chambers need to be filled only once in from three to eight months, according to size of wheel and use. As the chamber is sealed up, no dirt or drying influence can get to the oil. There is no breaking, firing, or removal of waste saturated with oil on account of being *clogged* with dirt.

There is no setting or sliding of the wheels, as often occurs with those rigged solid to the axles. If a wheel becomes worn, or by accident broken, it can be replaced without taking the pair together with the axle to the repair shop.

Experienced railroad men concede that at least from ten to twenty-five per cent. may be saved by adopting this new principle, and it is certainly worthy the attention of builders.

Mr. Bryant has several wheels running on exhibition in Machinery Hall, E–67, among which is a carriage wheel which makes 350 revolutions per minute, or a running distance of over 330 miles per day, and is expected to run at that rate for at least 100 days without further oiling, which will make in all over 33,000 miles, a thing unprecedented in the annals of self-lubricating machinery.

Mr. Bryant also has pulleys built on the same principle, a number of which are working through the Hall.

THE

POLYTECHNIC REVIEW.

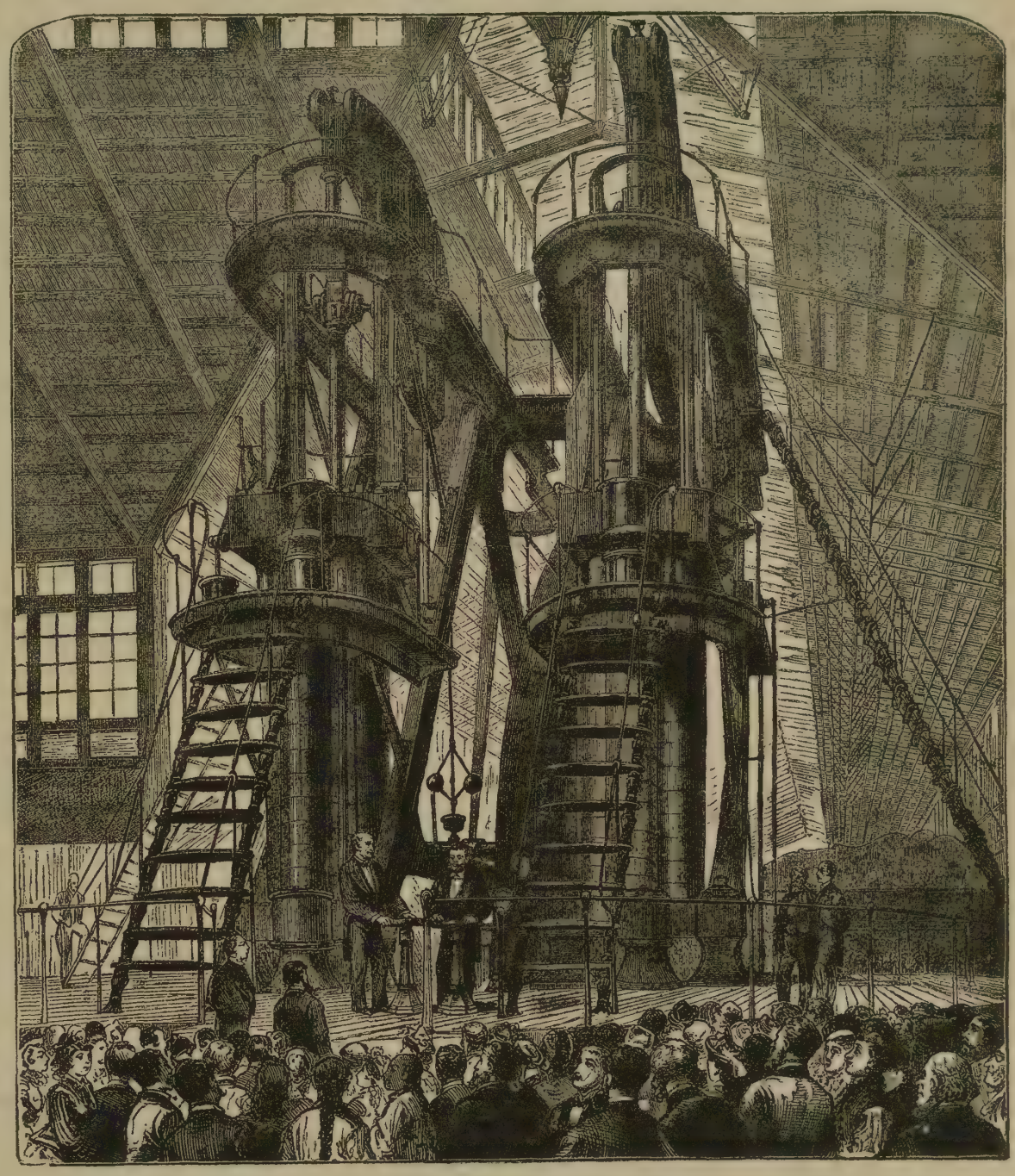
DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, JULY 15, 1876 NO. 2

THE GREAT CORLISS ENGINES AT THE CENTENNIAL.

The engraving given herewith shows the Corliss Engines of 1400 H. P., in Machinery Hall, as they appear to a spectator standing somewhat to the east of them. The design is uncouth and, perhaps, in some other respects faulty; although we refrain from any criticism upon the great motors until we can present detailed plans and descriptions accompanied by a record of performance.

We draw the present illustration from the handsome pages of "*Aurora Brazileira.*"



THE GREAT CORLISS ENGINES AT THE CENTENNIAL.

THE REMOVAL OF NIGHT SOIL.

V

In this article we desire to call attention to the improved water closet of George Jennings, of London. This is another device for dispensing with the pan and with the air-space between the bowl and the lower trap.

Fig. 25 shows the external appearance, and Fig. 26 shows a sectional view, of a closet designed to give, instantly on raising the handle, a regulated and assured quantity of water, with sufficient flush to cleanse the basin; by a closet "free from machinery; with no wires, cranks, levers, regulators, weights, or other complications; and which, in situations where subjected to severe frosts, will allow the surrounding enclosure to be filled with sawdust without in the least interfering with the action."

The trap and bowl are made in one piece of earthenware.

There is employed a peculiar "hydrostatic valve," which is an ordinary rubber disk flap-valve worked by a float, so that it remains open until the water reaches the prescribed level in the bowl.

"The sectional elevation (Fig. 27) represents the valve as shut, the closet being at rest. Upon raising the closet-handle, the water is discharged from the pan, causing the float (hitherto kept up by water), to fall; this action communicated to the brass spindle E, releases the pressure from the top of the diaphragm H, which, lifted by the pressure on the under side, allows the water to flow along the passage, L, in to the closet basin, as long as the handle remains raised. Upon releasing the handle, the water running into the basin lifts the float and spindle E, thus opening the passage again, allowing the water-pressure to act upon the top of the diaphragm, H, (through the passage B, thence round the groove on the outside of valve, and up the passage K), stopping the flow of water into the basin, the top area of valve being greater than the opening at the bottom. It is necessary that the diaphragm, H, should be equal to the pressure it has to work under; if not, the india rubber flange will burst and allow the water to escape into the pan; should it, however, be too strong for the pressure to lift, no water will run into the pan when the handle is raised; it is therefore requisite that the height of the cistern from closet-seat be stated when ordering these diaphragms."

Additional flushing of the trap may be obtained by the waste from a bath-tub or wash-basin. There is a ventilating orifice (V, Fig. 26), which may be connected with a chimney or passage.

These closets are expensive; but from the fact that only two joints are required to be made in order that the closet may be ready for use, the total expense is brought down to about that of ordinary closets.

A very efficient appliance for closets of any kind is the Jennings' self-acting disinfector, which acts in accordance with the well-known adage "Prevention is better than cure." It is intended to disinfect all fœcal matters on the instant of discharge, thus rendering them powerless for after offence before permitting them to escape; and to neutralize sewer-gases, and disinfect soil-pipes, house-drains, and sewers, by the liberation of the very waters used to wash away fœcal matters; these matters being charged with a powerful disinfectant. These objects should be accomplished without dependence on servants or individuals. Mr. Jennings' device (shown in fig. 29) is sufficiently explained by reference to the cut and the accompanying description.

A is a portion of the lead service pipe supplying the water closet basin with water, and into this pipe the end of the bent union (supplied with all disinfectors) should be soldered.

When the pressure of water is low, the bent end of the union should enter well into the bore of the pipe A, to insure a flow through it up the pipe S, over C, and down the pipe E, as shown.

This is most important, as the action of the disinfector depends entirely on the charging of these two pipes during the flow of water; for so soon as the flow ceases, the fall of the water in the pipes S and E produces or causes a vacuum in the upper pipe, which immediately siphons from the glass measuring chamber M the necessary charge of disinfectant fluid.

It is not material to the action of the disinfector how high the jar is fixed above the seat, but 4 feet or 4 feet 6 inches, as a rule, may be accepted as the proper height.

The breeches piece, C, should never be fixed more than 18 or 20 inches above the seat, unless the pressure of water is great, when it—as also the jar—may be both fixed at higher levels.

The disinfector and pipes should be neatly fitted at the back of closet, as shown; should a window prevent this, the whole may be fixed in one of the angles or on either side.

It is most important that the end of the pipe E discharging at the back of the basin should be so bent as to completely drain itself after every discharge; if attention is not given to this the siphon action will continue, and waste the contents of the jar.

Again, it is sometimes necessary to contract the end of the pipe E next the basin to check the flow, otherwise the disinfectant material may be siphoned from the glass chamber M immediately the handle is raised. This must be prevented, as the charge of disinfectant material should not pass to the basin until the water supply has ceased to flow.

JENNING'S COMBINED VALVE WATER CLOSET AND TRAP.

Fig. 25.—*Exterior View.*

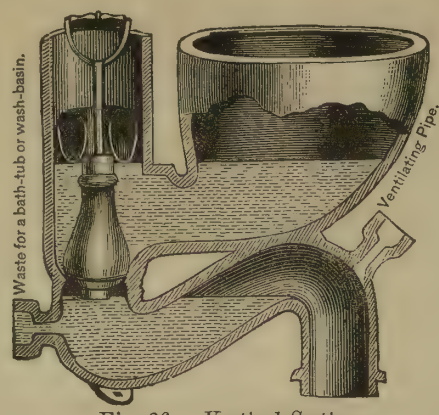


Fig. 26.—*Vertical Section.*

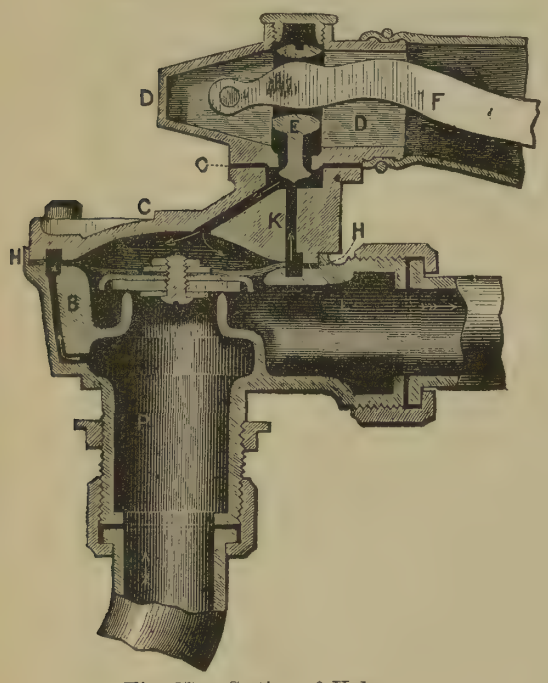


Fig. 27.—*Section of Valve.*

P Passage from Service Pipe of Cistern. L Delivery into Closet Basin. FLever connecting the Float with Valve. C Valve Cover. D Chamber in which the Spindle E works E Brass Spindle Valve. G Leather Seating for Spindle Valve. H Rubber Diaphragm. B & K Passages for water pressure. A Brass Fork upon which the Float is suspended.

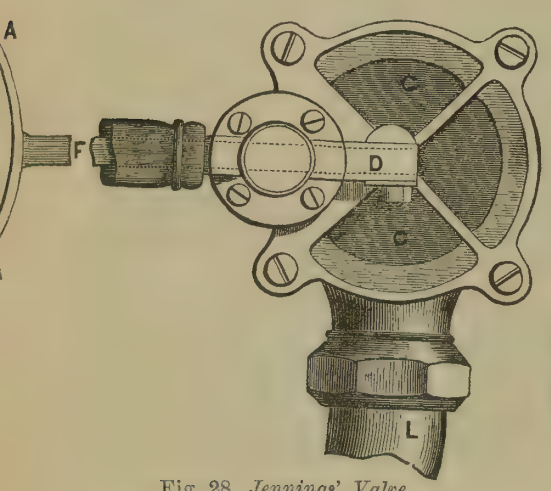


Fig. 28. *Jennings' Valve.*

Fig. 29.

Any kind of disinfecting fluid can be used in this apparatus, and the apparatus can be attached to urinals, sinks and other places. G.

(*To be continued.*)

[This series of illustrated articles on the removal of night soil, was commenced in the March number of the REVIEW. In article I, were described three systems of odorless excavation; in No. II, the pipe system was illustrated; in No. III, a ventilating pipe system was described; No. IV, was devoted to the "dry-earth" system.]

MILEAGE OF CAR-WHEELS.

From testimonials received by the Lobdell Car-Wheel Co., of Wilmington, Del., its wheels are shown to have run, without cessation of ordinary service, fourteen years; while on the Erie Road, they have been running over twenty years without removal. In Machinery Hall (E-65) are two wheels, concerning which it is stated that they have run under an engine on the Camden and Atlantic Railroad, 56,668 miles, without turning off; and that they will be used again after the Exhibition closes.

THE NEW BRAZILIAN SILK WORM, "SATURNIA AUROTA."

Dr. Nicolau Joaquim Moreira, the accomplished U. S. Centennial Commissioner from Brazil, furnishes us with the following classification and information concerning this remarkable insect, which is doubtless destined to do much for the wealth and prosperity of the empire of Santa Cruz.

"MIRROR-BEARING BUTTERFLIES. (PORTA ESPELHOS.)

Class—*Insects.* Order—*Lepidoptera.* Family—*Nocturnal.* Section—*Bombycian.* Genus—*Attacus.* Sub-Genus—*Saturnia.* Species—*Aurota.*

This butterfly is abundant in nearly all parts of the Brazilian Empire. It produces in each generation, on an average, 240 cocoons of silk. Each complete cocoon weighs 2½ drams and contains 30 grains of good silk.

The shred is yellowish, strong, elastic and continuous. A shred of a foot in length will suspend the weight of 4 drams, and a thread of 24 shreds the weight of ¾.

The larvæ feed on the leaves of the Palma Christi (Ricinus), of the Beriba (Anona), and principally of the Cajazeiro (Spondeas.)

The advantage of the culture of this serigenic lepidopter lies in using all the butterflies contained in the cocoons, without the necessity of destroying the silk for the winding up."

This moth is about seven inches across the wings from tip to tip, and about five inches long. It has a cocoon much larger than that of the *Bombyx mori*, or Chinese silk-worm; and produce about five times as much silk.

Dr. Moreira exhibits in the Brazilian section of Agricultural Hall, a complete illustrated history of this moth; and we learn from him that he has in preparation for publication a monograph on the subject.

Senhor Louis de Rezende, whose very interesting sericultural exhibit in Machinery Hall we described in our issue of June 20th, and who is an enthusiast in the silk culture in Brazil, warmly endorses the expression of the value of the Aurota, and will doubtless add his influence and care in its domestication and culture. G.

THE MECHANICAL ACTION OF LIGHT.

A Lecture delivered at the Royal Institution, London.

BY W. CROOKES, F. R. S.

II.

The pump here at work is a modification of the Sprengel pump, but it contains two or three valuable improvements. I cannot attempt to describe the whole of the arrangements, but I will rapidly run over them as illuminated by the electric light. It has a triple fall tube in which the mercury is carried down, thus exhausting with three-fold rapidity; it has Dr. McLeod's beautiful arrangement for measuring the residual gas; it has gauges in all directions, and a small radiometer attached to it to tell the amount of exhaustion that I get in any experiments; it has a contrivance for admitting oil of vitriol into the tubes without interfering with the progress of the exhaustion, and it is provided with a whole series of most ingenious vacuum-taps devised by Mr. Gimingham. The exhaustion produced in this pump is such that a current of electricity from an induction-coil will not pass across the vacuum. This pump is now exhausting a torsion-balance, which will be described presently. Another pump, of a similar kind but less complicated, is exhausting an apparatus which has enabled me to pass from the mere exhibition of the phenomena to the obtaining of quantitative measurements.

A certain amount of force is exerted when a ray of light or heat falls on the suspended pith, and I wished to ascertain—

First. What were the actual rays—invisible heat, luminous, or ultra violet—which caused this action?

Secondly. What influence had the color of the surface on the action?

Thirdly. Was the amount of action in direct proportion to the amount of radiation?

Fourthly. What was the amount of force exerted by radiation?

I required an apparatus which would be easily moved by the impact of light on it, but which would readily return to zero, so that measurements might be obtained of the force exerted when different amounts of light acted on it. At first I made an apparatus on the principle of Zollner's horizontal pendulum. For a reason that will be explained presently, I am unable to show you the apparatus at work, but the principle of it is shown in the diagram (Fig. 3). The pendulum represented by this horizontal line has a weight at the end. It is supported on two fibres of glass, one stretched upwards and the other stretched downward, both firmly fastened at the ends, and also attached to the horizontal rod (as shown in the figure) at points near together, but not quite opposite to one another.

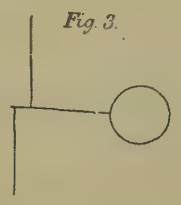


Fig. 3.

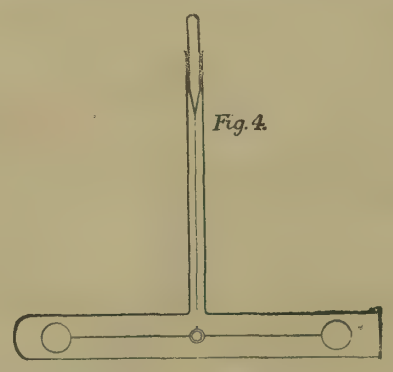


Fig. 4.

It is evident that if there is a certain amount of pull upon each of these fibres, and that the pull can be so adjusted as to counteract the weight at the end and keep it horizontal, the nearer the beam approaches the horizontal line the slower its rate of oscillation. If I relax the tension, by throwing the horizontal beam downwards, I get a more rapid oscillation sideways. If I turn the leveling screw so as to raise the beam and weight, the nearer it approaches the horizontal position the slower the os-

cillation becomes, and the more delicate is the instrument. Here is the actual apparatus that I tried to work with. The weight at the end is a piece of pith; in the centre is a glass mirror, on which to throw a ray of light, so as to enable me to see the movements by a luminous index. The instrument, enclosed in glass and exhausted of air, was mounted on a stand with leveling screws, and with it I tried the action of a ray of light falling on the pith. I found that I could get any amount of sensitiveness that I liked; but it was not only sensitive to the impact of a ray of light, it was immeasurably more so to a change of horizontality. It was in fact too delicate for me to work with. The slightest elevation of one end of the instrument altered the sensitiveness, or the position of the zero point, to such a degree that it was impossible to try any experiments with it in such a place as London. A person stepping from one room to another altered the position of the centre of gravity of the house. If I walked from one side of my own laboratory to the other, I tilted the house over sufficient to upset the equilibrium of the apparatus. Children playing in the street disturbed it. Prof. Rood, who has worked with an apparatus of this kind in America, finds that an elevation of its side equal to 1-36,000,000th part of an inch is sufficient to be shown on the instrument. It was therefore out of the question to use an instrument of this construction, so I tried another form (shown in Fig. 4), in which a fine glass beam, having disks of pith at each end, is suspended horizontally by a fine glass fibre, the whole being sealed up in glass and perfectly exhausted. To the centre of oscillation a glass mirror is attached.

Now a glass fibre has the property of always coming back to zero when it is twisted out of position. It is almost, if not quite, a perfectly elastic body. I will show this by a simple experiment. This is a long glass fibre hanging vertically, and having a horizontal bar suspended on it. I hold the bar, and turn it half round; it swings backwards and forwards for a few times, but it quickly comes back to its original position. However much twist, however much torsion, may be put on this, it always returns ultimately to the same position. I have twisted glass fibres round and kept them in a permanent state of twist more than a hundred complete revolutions, and they always came back accurately to zero. The principle of an instrument that I shall describe further on depends entirely on this property of glass.

Instead of using silk to suspend the torsion beam with, I employ a fibre of glass, drawn out very fine before the blow-pipe. A thread of glass of less than the thousandth of an inch in thickness is wonderfully strong, of great stiffness, and of perfect elasticity, so that however much it is twisted round short of the breaking point, it untwists itself perfectly when liberated. The advantage of using glass fibres for suspending my beam is, therefore, that it always returns accurately to zero after having tried an experiment, whilst I can get any desired amount of sensitiveness by drawing out the glass fibre sufficiently fine.

Here, then, is the torsion apparatus sealed on to a Sprengel pump. You will easily understand the construction by reference to the diagram (Fig. 4). It consists of a horizontal beam suspended by a glass fibre, and having disks of pith at each end coated with lamp-black. The whole is enclosed in a glass case, made of tubes blown together, and by means of the pump the air is entirely removed. In the centre of the horizontal beam is a silvered mirror, and a ray from the electric light is reflected from it on to a scale in front, where it is visible as a small circular spot of light. It is evident that an angular movement of the torsion beam will cause the spot of light to move to the right or to the left along the scale. I will first show you the wonderful sensitiveness of the apparatus. I simply place my finger near the pith disk at one end, and the warmth is quite sufficient to drive the spot of light several inches along the scale. It has now returned to zero, and I place a candle near it. The spot of light flies off the scale. I now bring the candle near it alternately from one side to the other, and see how perfectly it obeys the force of the candle. I think the movement is almost better seen without the screen than with it. The fog, which has been so great a detriment to every one else, is rather in my favor, for it shows the luminous index like a solid bar of light swaying to and fro across the room. The warmth of my finger, or ths radiation from a candle, is therefore seen to drive the pith disk away. Here is a lump of ice, and on bringing it near one of the disks the luminous index promptly shows a movement of apparent attraction.

With this apparatus I have tried many experiments, and amongst others I endeavored to answer the question "Is it light, or is it heat, that produces the movement?"—for that is a question asked me by almost everyone; and a good many appear to think that if the motion can be explained by an action of heat, all the novelty and the importance of the discovery vanish. Now this question of light or heat is one I cannot answer, and I think that when I have explained the reason you will agree with me that it is unanswerable. There is no physical difference between light and heat. Here is a diagram of the visible spectrum (Fig. 5). The spectrum, as scientific men

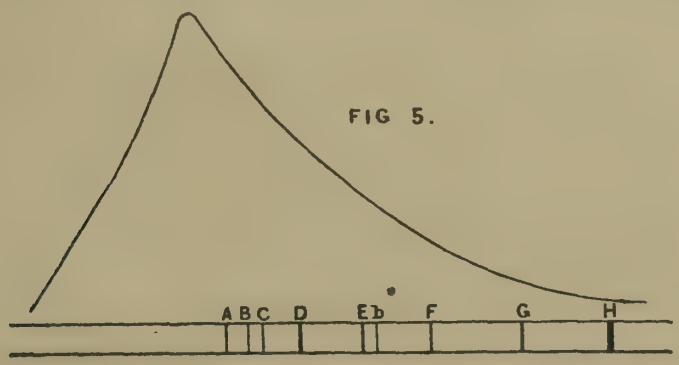


FIG 5.

understand it, extends from an indefinite distance beyond the red to an indefinite distance beyond the violet. We do not know how far it would extend one way or the other if no absorbing media were present; but, by what we may call a physiological accident, the human eye is sensitive to a portion of the spectrum situated between the line A in the red to about the line H in the violet. But this is not a physical difference between the luminous and non-luminous parts of the spectrum; it is only a physiological difference. Now, the part at the red end of the spectrum possesses, in the greatest degree, the property of causing the sensation of warmth, and of dilating the mercury in a thermometer, and of doing other things which are conveniently classed among the effects of *heat;* the centre part affects the eye, and is therefore called *light;* whilst the part at the other end of the spectrum has the greatest energy in producing *chemical action.* But it must not be forgotten that any ray of the spectrum, from whatever part it is selected, will produce all these physical actions in more or less degree. A ray here, at the letter C for instance, in the orange, if concentrated on the bulb of a thermometer, will cause the mercury to dilate, and thus show the presence of *heat;* if concentrated on my hand I feel *warmth;* if I throw it on the face of a thermo-pile it will produce a current of *electricity;* if I throw it upon a sensitive photographic plate it will produce *chemical action;* and if I throw it upon the instrument I have just described it will produce *motion.* What, then, am I to call that ray? Is it light, heat, electricity, chemical action, or motion? It is neither. All these actions are inseparable attributes of the ray of that particular wave-length, and are not evidences of separate identities. I can no more split that ray up into five or six different rays, each having different properties, than I can split up the element iron, for instance, into other elements, one possessing the specific gravity of iron, another its magnetic properties, a third its chemical properties, a fourth its conducting power for heat, and so on. A ray of light of a definite refrangibility is one and indivisible, just as an element is, and these different properties of the ray are mere functions of that refrangibility, and inseparable from it. Therefore, when I tell you that a ray in the ultra red pushes the instrument with a force of 100, and a ray in the most luminous part has a dynamic value of about half that, it must be understood that the latter action is not due to heat-rays which accompany the luminous rays, but that the action is one purely due the wave-length and the refrangibility of the ray employed. You now understand why it is that I cannot give a definite answer to the question—"Is it heat or is it light that produces these movements?" There is no physical difference between heat and light, so, to avoid confusion, I call the total bundle of rays which come from a candle or the sun, *radiation.*

I found, by throwing the pure rays of the spectrum one after the other upon this apparatus, that I could obtain a very definite answer to my first question—"What are the actual rays which cause this action?"

The apparatus was fitted up in a room specially devoted to it, and was protected on all sides, except where the rays of light had to pass, with cotton-wool and large bottles of water. A heliostat reflected a beam of sunlight in a constant direction, and it was received on an appropriate arrangement of slit, lenses, prisms, &c., for projecting a pure spectrum. Results were obtained in the months of July, August, and September; and they are given in the figure (Fig. 5) graphically as a curve, the maximum being in the ultra-red and the minimum in the ultra-violet. Taking the maximum at 100, the following are the mechanical values of the different colors of the spectrum:—

Ultra-red	100
Extreme red	85
Red	73
Orange	66
Yellow	57
Green	41
Blue	22
Indigo	8½
Violet	6
Ultra-violet	5

A comparison of these figures is a sufficient proof that the mechanical action of radiation is as much a function of the luminous rays as it is of the dark heat-rays.

[*To be continued.*]

MODERN FIRE ENGINES.

V

PUMPS—CONTINUED.

THE GOULD PUMP.

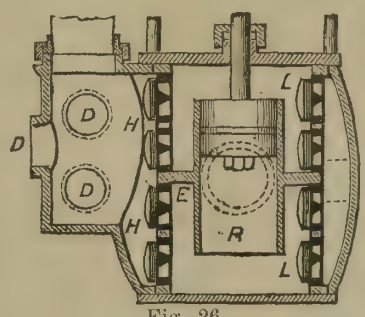


Fig. 26.

The pump on the "Gould" engine, as here shown (Figs. 26,27) in vertical and horizontal cross sections, is double-acting and vertical; and to it is due much of the reputation of the Gould as a far throwing machine. It has three concentric shells. The inner and shorter is the pump barrel (R) which is cast in one piece with the valve shell; the two being connected by an annular web which divides the annular space horizontally into two chambers, each opening into one end of the pump-barrel. By taking off the bottom cover the two connected shells may be dropped out of the outer shell, and all the valves reached. The valve-shell is heptagonal or seven-sided in section; each face bearing 4 valves, the seats of which are screwed into the plane faces of the shell. A vertical partition (P) divides the outer annular space longitudinally into two chambers, the larger of which contains five faces of the valve-plate, each bearing 4 suction valves (20 in all). The smaller chamber has two faces of the valve-plate, each bearing 4 discharge valves (16 in all). At each up-stroke and at each down-stroke, the water passes ten suction valves and four discharge valves, of equal area, each one with the other. The plunger packing is two cup-disks of leather, back to back. The valve (shown in Fig. 28) is of brass, rubber-packed; the rubber giving tightness, and the metal preventing driving into the opening. The water flows by the valve both by the outside and by the centre, preventing clogging

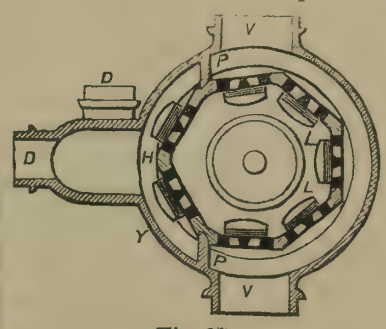


Fig. 27.

by dirt; and it is guided on a stud (S) by knife-edged projections (W) preventing sticking. As the seat of the valve screws into the valve-plate, which last is easily and quickly removed, an accident to the valves may be readily remedied. In the second class double Gould engine, each (double-acting) pump has 20 suction valves, with united areas of 60 sq. inches. The cross area of each pump-barrel is 16.8 sq. inches. The united areas of the 8 discharge valves is 24 sq. inches. There are two inlets each 19½ sq. inches area; and three discharge outlets of 14.7 sq. inches united area.

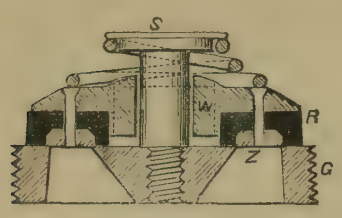


Fig. 28.

Hereafter there will be 24 suction valves in each pump on the second class machines, so that the area of the suction valves at each end may be fully equal to that of the pump-barrel, as is the case with all the other sizes.

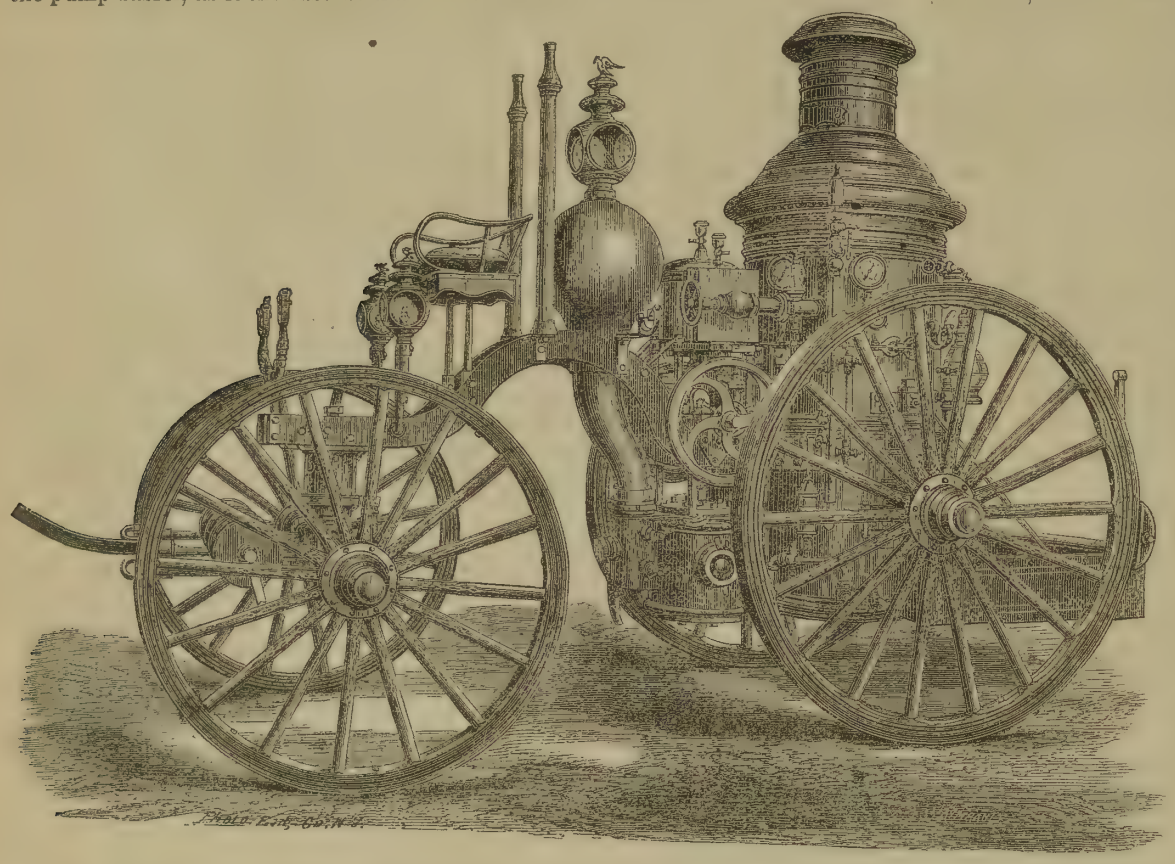


*Fig. 29.—GENERYL VIEW OF GOULD CRANE NECK STEAM FIRE ENGINE.

The pump-barrel and valve-plate are of brass; the outer shell, of brass or iron. With 80 lbs. steam pressure, and making 344 revolutions per minute, the capacity of the machine is stated to be 800 gallons per minute.

A detailed longitudinal vertical section of the Gould Crane Neck Engine is given in vol. I, page 19. G.

[This series of illustrated articles was commenced in the February number of the REVIEW. In Nos. I, II and III, are described the Latta, Silsby, Merryweather, Clapp & Jones, Amoskeag, Dennison, Button, Gould, Shand & Mason, Roberts, and Jacket boilers. No. IV gives the Silsby and Amoskeag pumps; No. V, the Clapp & Jones pump.]

SOME FACTS CONCERNING MATCHES.

The following points in the history of the art of producing fire by artificial means, as gleaned from trustworthy sources, will serve the purpose of introducing certain suggestions of needed reform, which appear to be urgently called for.

Passing by the fabulous stories which relate how the impious Prometheus first bestowed upon his fellow creatures the inestimable knowledge of the use of the sacred element, and got himself into a world of trouble in consequence thereof, and the indefinite period during which our early ancestors were obliged to go through the laborious process of innocently illustrating the mechanical theory of heat by producing fire from the friction of two pieces of wood, the tinder-box with flint and steel, which is known to have been employed as early as the fourteenth century, brings us with one stride down to times comparatively recent. This eminently useful device remained in almost universal use until the year 1820, in which Doebreiner, of Jena, made the curious discovery of what, for want of a better name, has been called the catalytic action of platinum sponge, in virtue of which this substance, by condensing certain gases upon its surface, becomes highly heated and effects their ignition. This discovery resulted in the production of the famous hydrogen lamp, which soon became extremely popular, and is even yet, though rarely, to be found in use. Although of no direct influence upon the production of the match, the discovery of Doebreiner nevertheless, by directing attention to the improvement of fire-giving devices, aided doubtless indirectly in its improvement.

Almost simultaneously with the Doebreiner lamp a fire-giving device was invented which is worthy of special mention, in the history of this industry, inasmuch as it appears to have been the first device which availed itself of the great inflammable qualities of phosphorus. It is described by Wagner† as follows:—Equal parts by weight of sulphur and phosphorus were carefully melted together in a glass tube or flask. This was then colored with a cork and the mixture thus preserved. When a flame was required, the cork was removed, a splint of dry wood was inserted into the sulphur-phosphorus mixture, and withdrawn, when the small quantity adhering to the stick ignited, and communicated the fire to the wood. This fire-flask appears to have only obtained a limited use in Germany, and is now completely forgotten. Earlier than this, Chancel had devised the following system, which was extensively employed until about the year 1844. A bottle was furnished with asbestos fibres which were saturated with concentrated sulphuric acid. To obtain a flame, a match, prepared by first dipping in melted sulphur, and then tipped on the sulphur end with a mixture of chlorate of potassa, sugar and gum (sometimes with a little cinnabar as a coloring matter), was brought into contact with the acid, which caused immediate combustion. This system, though obviously of somewhat limited utility, is nevertheless an excellent one, and has the merit of being quite safe. The so-called Prometheans, introduced in England about the year 1830, employed the same principle. They were made of a small tube of paper containing chlorate of potassa and sugar, and carried at one end a minute glass bulb filled with sulphuric acid; this bulb, when crushed (generally in a pair of tongs carried for the purpose), allowed the acid to come in contact with the mixture, and thus effected the ignition. The Prometheans, which because of their costliness never came into very general use, form the transition to the friction match proper. We glean from Wagner, that the first friction matches were the so-called Congreves, which were introduced about the year 1832. In these, the sulphur-tipped splints were covered with a mixture composed of one part of chlorate of potassa and two parts of gray sulphide of antimony, with the addition of some glue or gum. In order to ignite them, it was necessary to draw them through two surfaces of sandpaper held between the fingers. The amount of friction required to effect ignition was so considerable, that the heads were often torn from the splints and deflagrated between the rubbing surfaces and failed to ignite the wood.

Bolley, to whose admirable *Handbuch d. Chemischen Technologie*, we are indebted for much of the information that follows, affirms that about the same year, and more decidedly during the years 1833 to 1835, phosphorus matches made their appearance in various countries. The ingredients of these matches were phosphorus, chlorate of potassa, sulphide of antimony and gum, which last ingredient was soon largely replaced by glue. These ignitable compositions were very dangerous both in their manufacture and use; the frequent explosions in the factories, the occurrence of accidents from their ignition during transportation, etc., caused the manufacture and sale of the early phosphorus matches to be legally forbidden in certain countries. The desirability of finding a less dangerous substitute for the chlorate of potassa and sulphide of antimony, speedily led to the employment of saltpetre, mixtures of the oxides of lead and manganese, and of the mixture of superoxide of lead and nitrate of lead resulting from the treatment of red lead with nitric acid. The chief fault of the earlier match compositions resided in the fact that they contained too high a percentage of phosphorus. The odor of the matches was, consequently, extremely unpleasant, and their durability very uncertain. In the preparation of compositions containing so notable a quantity of phosphorus, it was impossible to prevent its partial combustion, and the phosphoric acid that found its way into the mixture, by its eminent hygroscopic qualities, contributed to the rapid destruction of the paper boxes in which the product was packed, and to the deterioration or ruining of the matches themselves. The last-named difficulties were practically overcome by coating the heads of the matches with a film of water-proof varnish, which not only did away with the objectionable smell of the phosphorus, but rendered the product practically indifferent to the ordinary atmospheric changes.

The improvements that have of late years been introduced into the manufacture of phosphorus match compositions, have been, generally speaking, the reduction of the relative amount of phosphorus to a minimum, and the substitution of other oxygen-giving substances, saltpetre and meta llic peroxides, nitrates, chromates, etc., in place of the chlorate of potassa. The manipulation of this substance in contact with phosphorus is attended with great danger, since such mixtures are very liable to explode; and furthermore, the matches prepared with this composition ignite with a more or less violent detonation, or are apt, owing to the intensity of their combustion, to throw off burning particles quite persistently. The use of chlorate of potassa, it is proper to add, is now, however largely abandoned in favor of the cheaper substitutes before named, which, while they completely answer every practical purpose, are decidedly less dangerous both in manufacture and use.

Inasmuch now, as the theory of the production of a match involves the employment in the mixture of two different classes of substances—one, a substance rich in oxygen and yielding it up readily, and the other, a readily inflammable one—it will be obvious from the preceding comments that the perfect phosphorus match—other things being equal—will be that in which the necessary degree of inflammability is attained with the smallest possible quantity of phosphorus. There are, however, certain evils inseparable from the employment of phosphorus mixtures for matches, both in the process of manufacture and as regards their general use, that have very properly been made the text of repeated protests against their use notably by the insurance interest, and has given great stimulus to the invention and introduction of so-called anti-phosphorus and safety matches.

A grave objection to the phosphorus matches resides in the fact that they are highly poisonous, and hence they frequently give rise to distressing accidents to children; the workmen in the manufactories, however, are the greatest sufferers from this cause, and from constant exposure to the vapors of phosphorus, are afflicted with frightful caries of the jaw-bone. W.

[*To be continued*]

* We give *Fig.* 29 by courtesy of the *Scientific American.*
† *Vide* Wagner, Handbuch der Chemischen Technologie page 631.

CROWDED OUT.—Bibliographical Notices and Illustrated "Centennial Note" of the Teal Punching Press, together with a few minor items, are unavoidably carried over to the Industrial Department, page viii.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

Compound Cylinder Locomotives.—We learn from *Engineering*, (xxi, 479), that a compound cylinder locomotive is on trial on the Bayonne Biarritz R. R. It is the first of a series built by Schneiders of Creusot, on the compound principle of A. Mallet, of Switzerland. There are two cylinders, 9½″ and 16″ diam., 17⅜″ stroke; using boiler pressure of 150 lbs. The engine is normal gauge, and 20 tons' weight. In ordinary circumstances the steam is admitted in the small cylinder and expands in the other; but when starting, or when more power is needed, each cylinder works with separate admission and exhaust. There are but 516 sq. ft. of heating surface.

We greatly regret that the "compound" delusion is receiving serious consideration as applied to locomotives, and cannot predict for it any degree of success.

Popoff's Water Bag.—Capt. Singer tested this device at Portsmouth; using a bag 21 ft. long, 12 ft. diam., in the hold of dock-yard lighter. On the first day, with a partly inflated bag, the lighter was raised somewhat; but with full inflation, owing to part of the bag coming above water and losing some of its bouyancy, no further raising could be effected. (Abr. from *Engineering*, xxi, 486.

The Canal from the Hudson to the Mississippi will soon be completed. The two principal rivers—the Fox and Wisconsin—together form an almost unbroken water way from the Father of Waters to the great lakes. In a few weeks the canal which is to join the two is to be completed, and Wisconsin will honor the event with appropriate ceremonies. The Wisconsin should, however, be replaced in the waterline, from Portage, by a canal 118 miles long, estimated to cost $4,164,270.

Button Sewing Machine.—Mr. J. W. Fries has invented a machine for sewing on perforated buttons. We hope to illustrate it shortly.

The Flooding of the Sahara.—Mr. M'Kenzie, with a party of ten, will leave London in the beginning of next month for Western Africa, for the purpose of making the necessary surveys preliminary to turning the waters of the Atlantic into the great sink or basin which extends from the valley of the Bella to Timbuctoo. He is very confident that a canal eight or nine miles long will suffice to accomplish the great operation which he contemplates, and bring the mysterious capital of equatorial Africa within six or seven days' sail of the Thames. If he succeeds, there can be no doubt as to the immense development of trade that will ensue; and, to some extent, the condition of the natives will doubtless be ameliorated, although the introduction of European civilization has not always proved an unalloyed good to the negro races. And even if the main project fail, there can be little difficulty in establishing a good land route, with a base at some part of the coast accessible to shipping; for the climate at this point, on the parallel of the Canary Islands, unlike that of the present commercial depots, suits European constitutions well enough. [*Iron.*]

Trial of Steam Tram Engines in Yorkshire.—Engineering (xxi, 418) states that a steam street car, built by Merryweather & Sons, of London, was recently tried, with great satisfaction, and that these engines have been for some time running on one of the Paris lines.

H. M. S. Serapis.—This vessel, on her recent cruise, ran 17,542 miles, traveling 18,000 knots in 1,780 hours; burnt, in doing so, 5,415 tons of coal, and made 4,698,743 screw revolutions, her speed varying according to circumstances. [Abr. from *Engineering*, xxi, 418.]

Stockwell's Tubular Life-Saving Vessel (illustrated in *The Engineer* xli, 394), is built in the form of a cylindrical or flattened hollow ring. The interior of the tube forms the cabin for the crew; the central circular space has a sliding keel; such masts are stepped as may be desired.

R. R. Statistics for 1875.—Poor's Railroad Manual of the United States for the current year, gives the total mileage of railroads completed in the United States at the close of 1875, as 74,658 miles.

Force of the 81-*Ton Gun.*—A plank with a piece of stone on it was laid on the ground in front of the gun exactly under the muzzle, which was about seven feet above it. The downward blast force of discharge drove the stone through the plank, and the blow was so nearly vertical that the fragments were scarcely moved from their place. [*Standard.*]

Strophometer.—The Society of Arts has awarded the gold medal for the best marine revolution indicator, to J. A. Hearson, of Greenwich.

Cost of English Locomotives.—Mr. Price Williams states the average gross cost of 2,000 engines of the London & Northwestern Road to be £2,200 ($11,000), the average scrap value being £400 ($2,000), leaving £1,800 ($9,000) as the net cost of each engine and tender. The average annual cost of maintenance and renewal is £164 ($820), giving credit for the scrap; thus the cost of 11 years repairs would renew the engine. [Cond. from *The Engineer*, xli, 415.]

Knight's Steam-Power Digging Machine (illustrated in *The Engineer*, xli, 394), and especially intended for hop-gardening, has a three-wheeled frame; from the axle of the two rear wheels are driven, through gearing, three forks on a three-throw crank. Each fork-staff being held by an arm one fourth of its length from the bottom, the tine describes an oval.

Inventor of the Reaping Machine.—We learn from *Engineering* (xxi, 419), that a monument may be erected to Rev. Patrick Bell, of Carmyllie, to commemorate his invention of the reaping machine.

Portable Steam Launches.—Messrs. Yarrow & Co., of Poplar (says *Engineering*, xxi, 419), have just completed two steel vessels, 30x8 ft., for Lake Nyassa. These vessels are *bolted* together to admit of transportation on men's backs.

A Novel Twin Staircase and Elevator has a double spiral staircase, surrounding a central well in which is an elevator. [Illust. in *Sci. Am. Supp.*, ii, 440.]

New Alpine Tunnel.—A company has been formed at Lausanne, to tunnel the Simplon from Brigue to Pelle, 11.4 miles. [Abr. from *Sci. Am. Supp.*, ii, 417.]

Spiral Steam Jacket.—The *Bulletin du Société d'Encouragement*, proposes to place spiral partitions in the annular space of a steam jacket, and thus to compel the steam to traverse its whole extent.

The *Société d'Encouragement* has this year voted the great Prony prize for the most successful invention in mechanics described during a certain number of years, to M. Henry Giffard, of Paris, for his invention of the injector that bears his name.

MINING, METALLURGY AND MINERALOGY

The California Soap Mines.—The rock-soap mine is situated in the lower mountains or foot hills in the coast ranges in Ventura Co., five miles from the city of the same name. It was discovered by A. F. Hubbard, while prospecting for coal. He accidentally dislodged some that fell into the water and dissolved. It being a new experience to see rock dissolve, he gave it his attention, found it soapy, took it home to experiment with, and soon learned its virtues. His family used it for nearly a year before it was given to the public, when the discoverer associated himself with others, and formed a company which is now working the mine. * * * The rock resembles chalk or lime; at the southern extremity of the mine is an extensive deposit, veined, marbled, and parti-colored, resembling castile soap. The ledge at its opening is fifteen to twenty feet wide, and crops out for two thousand feet with an unknown depth. The lode is well defined with wall rocks of hard slate, in common with which it has been turned completely on edge. In its vicinity is a mountain of gypsum similarly upturned.—*San Benventura (Cal.) Reporter.*—[As to what may be the composition of this extraordinary substance, "deponent sayeth not."—ED.]

Blown Cast-Iron.—Considerable attention has lately been attracted in Belgium, to a method of partially refining cast-iron, previous to puddling, put in practice by M. Fernard Hamoir. The process consists in submitting the cast-iron, at the instant it is tapped from the blast furnace, to a current of air from the same blast that is being supplied to the tuyeres of the furnace itself; the process is very rapid, and the apparatus simple and inexpensive, while the advantage obtained is, that the pig iron is so far refined that one charge more per twenty-four hours can be worked in the puddling furnace. [*Moniteur des Interets Materiels.*]

Nickel Mines of New Caledonia.—Reports to the French papers from New Caledonia speak of an active extraction of nickel ore, more particularly at Canada and Houailon, where very rich mines are situated. Mr. Higginson, who has done much to promote the mining industry of New Caledonia, has lately sent 500 tons of nickel ore to Havre. Blast furnaces are stated to be in course of erection there for treating ores on the spot. M. Garnier has patented a system of treating nickel ore for getting crude metal from it, in a puddling furnace with movable bottom, and refining by the action of an oxidizing flame on the smelted nickel pig. The metal may also be won direct by reducing oxides in a blast furnace, and M. Garnier prepares *an alloy of iron and nickel*, which he hopes will be of great utility in the arts. The alloy is produced by the addition of nickel to a bath of melted iron or steel. It is stated to be inoxidizable and of great toughness. [*Eng. & Mining Jour.* xxi, 559.]

The Sherman Process of steel conversion in the Martin Furnace, is occupying the attention of French metallurgists. The most important experiments were conducted at M. Veriere's Works, at Firminy, and the Terre-noire Works are said to have paid Mr. Sherman a large sum for the French patent. The St. Etienne *Société Minerale* has now been offered the use of one or more of the Terre-noire Martin Furnaces for experimenting on phosphorus steels, either with ferro-manganese, or the Sherman process. The latter, which is based on the addition of homœopathic doses of iodide of potassium to the melted pig is beginning to be discredited, the proportion being abont the third of an ounce to the half ton.

CHEMISTRY, PHYSICS AND TECHNOLOGY

A New Copper Paint is made from porous electrolytic copper, mixed with a benzine varnish. When mixed with oil, the copper acquires an antique green hue.

An Improved Military Telegraph, illustrated in *La Nature*, has an insulated cable containing two wires, and wound upon a reel; the receiver gives the message by sound; the whole apparatus is in knapsack shape.

A Sextuple Telegraph is working between Paris and Lyons, giving 150 messages per hour on one wire. [*Annales Telegraphiques.*]

Oakum-Combing Prize.—The *Société Industrielle du Nord de la France* offers $1000 as a prize for an improved oakum combing machine; a kilogramme (2.2lbs.) to be converted by it into tow at a cost not exceeding 10 centimes for labor, general expenses, and interest on capital.

Harmless Glaze for Earthenware.—The *Society of Arts Journal* states that M. Constantin of Brest, produces a harmless glaze with silicate of soda, silex, and minium. Another recipe is 100 parts of silicate of soda, 15 of quartz, 15 of Meudon chalk; another is the same, plus 10 parts of borax, which renders the glaze more fusible and brilliant. Copper colors the articles green, and manganese brown.

To distinguish between Madder and artificial Alizarine, it is recommended to dip the fabric under examination in a solution of potassium permanganate, and then in a bath of acid, when the madder red will become yellowish, but artificial alizarine will turn distinctly rose colored. The difference in color is still better perceived by treating the dyed cotton with potassium dichromate and nitric acid successively; in this case the madder red is almost completely decolorized, while the red of artificial alizarine preserves a characteristic rose color. If the fabric is further treated with soda lye (of 18° B.) and then with hydrochloric acid (of 20° B.), the madder red becomes of a dirty orange, while the artificial alizarine turns a brilliant clear yellow. [*Am. Chemist* vi, 398.]

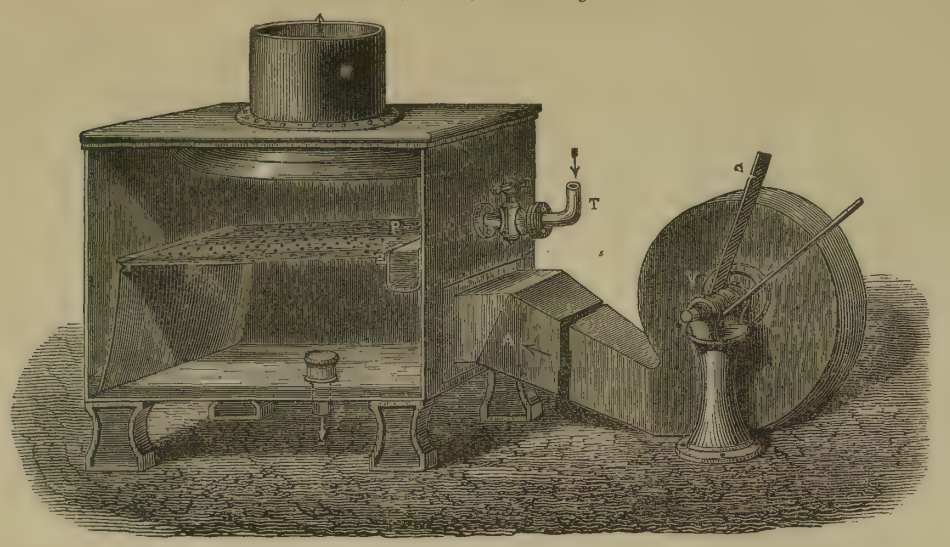
Preservation of Timber for Mines.—Herr O. Koug packs the timber, cut in proper lengths, in a vertical position in an iron reservoir, provided with a tight fitting cover. The vessel is then filled to about three-fourths of its capacity with a solution of the carbolate of soda. Into this he leads live steam, which speedily brings the liquid to the boiling point. The access of the steam is continued until, by its gradual condensation, it has filled the vessel to its full capacity. The wood is then allowed to remain in the hot liquid for some hours; this is then drawn off, and the wood washed off with a dried steam jet. [*Berg. u. Hüttenmännische Zeitsch.* xxxv, 1787.

The Atomic Weight of Cerium.—Herr Heinrich Bührig has succeeded, by a modification of Gibb's method [*Am. Jour. Sci.* [2] xxxvii, 352], which he affirms to be the best yet devised, in preparing very pure salts of cerium. The spectroscopic examination of these compounds showed no absorption spectrum of didymium. He has determined the atomic weight of cerium by the combustion of the oxalate, and gives it the value Ce = 94·1782. [*Journal für Praktische Chemie.*]

An Improvement in the Filter-Pump.—Dr. Walker Hempel suggests, as a means of quickening the action of the filter-pump, that a series of five radial lines be etched in the funnel, from a point 9 to 12 mm. below the top of the filter to the neck. By this system of little canals, the action of the apparatus is affirmed to be considerably accelerated. [*Fresenius Zeitschrift*, through *Am. Chemist* vi, 395.]

GARLANDAT'S AIR COOLING AND PURIFYING APPARATUS.

Exhibited by J. J. Besson, of Paris, in the French Department, Centennial Exhibition. Section D, No. 1, Machinery Hall.



V Blower. P Perforated Plates. E Outlet for Refrigerated Air. A Air Entrance. T Pipe Conducting the Water. t Outlet for the Water.

AS THE AIR, SO IS THE BLOOD.—This very simple, useful, economical and practical apparatus filters the atmospheric hot air through water, thus purifying and cooling it, and forces it to the places where it is wanted.

Well or spring water will supply the liquid; its temperature in all places under the surface, no matter what the temperature of the climate, is generally 52° to 56°; if a lower temperature is required, this can be obtained by placing ice or frigorific materials.

The machine, to be set at work, requires a very moderate force, and several thousand cubic feet of air per hour may be cooled with a plate measuring three square feet. When humidified or saturated air is required, for spinning factories, etc., heated water is employed upon the plate.

Having indicated the arrangement of this apparatus, it is for builders to examine into its merits. It would require an extended space to point out the advantages derived by its adoption in public and private buildings, banks, manufactories, etc.; its use, not only cooling the air, saturating it if required, but purifying it of all carbonic acid and other deleterious agents.

Intelligent manufacturers may easily discover the application to their industry of this new method. It may be alleged that the cooled air is susceptible of carrying with it too much moisture; it is easy to show that this objection is unfounded, and that, on the contrary, the moisture of the air, on leaving the apparatus, can be increased or diminished at will, and it is needless to refer to the very simple and well-known plan by which this is done.

Many eminent scientific men in France have written pamphlets on the Air Refrigerator, amongst them are Dr. A. Bertherand, Dr. A. Jouglet; this latter, in the *Moniteur Scientifique* of Dr. Quesneville, concludes by saying: "I have attempted to develop a question upon which very incomplete essays have been published—finding among the many proposed solutions of an important question, one apparatus which, by its simplicity, utility and economy, appears to meet every requirement, and I have not hesitated to highly recommend it."

Antiseptic Properties of Thymol.—Lewin communicates the following facts to *Gœa* relative to the antiseptic and antifermentative properties of thymol. This substance, thymol, obtained from the oil of thyme by distillation, occurs in white, highly aromatic crystals; when dissolved in hot water in the proportion of 1 part per 1,000, it forms a fully saturated solution possessing a neutral reaction. A more concentrated solution is impossible to obtain. Lewin finds that 0.1 per cent. of this solution is sufficient to prevent fermentation in sugary liquids, no matter what the proportion of sugars and yeast. Milk, to which a small quantity of the thymol solution was added, did not begin to show signs of coagulation till twenty days later than milk with which an equal quantity of water had been mixed. Filtered white of egg, in contact with the air, was found to grow putrid in three or four days, whereas white of egg with which thymol water had been mixed, gave not the slightest indication of putridity after eleven weeks. The same results were obtained in treating pus with water and thymol: pus so treated at once lost its putrid odor and continued to be odorless for five weeks, or until it became dry. [*Popular Science Monthly.*]

Lighting by Petroleum.—The authorities of Dudley, England, have under consideration the advisability of lighting that town with petroleum, at a saving of 14s. per annum per lamp. Winchester and other towns are lighted with oil.

The Rumford Medal **has just been awarded by the American Academy of Arts and Sciences to Dr. John W. Draper, for his researches in radiant energy.**

Electric Light on Shipboard.—The General Transatlantic Steamship Company's steamship Amerique has been provided with an electric light for purposes of illumination at sea. The apparatus used is one of Gramme's magneto-electric machines, and the propelling power, a small but powerful engine. The lamp is constructed of two pointed pencils of a species of coke, one-half inch square, and about four or five inches in length, which will last some four hours, and are kept at the distance from each other, as they are consumed by a system of clock-work. The light is affirmed to be plainly visible at a distance of fifteen miles at sea, and lights the ship so perfectly that all the details of her equipment and rigging are rendered distinctly descernible at a distance of more than a mile. The lamps, which also serve the purpose of furnishing light to work the ship at night, can be lit, lowered or extinguished in any part of the ship by the switch-board in the cabin of the captain.

The Amerique is the first vessel that has been furnished with this system of illumination, which is affirmed to give complete satisfaction. The expense of the light, including interest on the investment, is about eighty cents a day. [*Technologist.*

Estimation of Carbonic Acid.—Dr. O. Vibrans bases a process upon the decomposition of the carbonates by acids and the combination of the carbonic acid with a dilute solution of caustic baryta of definite strength. The solution of baryta free from caustic-fixed alkalies, is standardized with a freshly prepared solution of oxalic acid, containing two grammes of acid to the litre, so that equal volumes of the solutions will neutralize each other. A tincture of turmeric is used to indicate the end of the reaction. The usual volumetric process is then employed with the necessary precautions. [*Am. Chemist*, vi, 437.

The Preparation of Pure Salts of Nickel from the Nickel of Commerce. [M. A. Terreil.]—The nickel of commerce is an alloy of nickel, copper and iron, with small quantities of arsenic. The proportion of nickel in this alloy varies from 40 to 90 per cent. The method generally employed to prepare the salts of nickel from the metal of commerce, consists in making an acid solution, out of which the copper and the arsenic are separated by the use of sulphuretted hydrogen, and the per-oxide of iron by excess of ammonia; the result of these operations is the production of an ammoniacal salt of nickel, from which it is difficult to eliminate the ammonia.

M. Terreil proposes a new treatment of the nickel of commerce, which dispenses with the use of both sulphuretted hydrogen and ammonia, and which furnishes a pure sulphate of nickel, directly and with a material economy over the old method. The process in question consists of four operations, as follows:—1st, the solution of the nickel in acid; 2d, precipitation of the copper by iron; 3d, the peroxidation of the iron and the transformation of the metals into sulphates, and 4th, the precipitation of the iron by carbonate of baryta, and crystallization of the sulphate of nickel.

1st operation.—The metal is treated with from seven to eight times its weight of *aqua regia*. The solution thus obtained is evaporated almost to dryness; and on the addition of water, all of the salts formed will dissolve, except a certain quantity of the arseniate of iron, which is separated by filtration.

2d operation.—A piece of clean iron is introduced into the cold liquor, which precipitates the copper in the metallic state. The operation is very rapid, and is complete when a clean iron surface introduced remains bright.

3d operation.—The liquid now contains nothing but iron and nickel, and the former is oxidized, either by passing through it a current of chlorine, or by the use of nitric acid. Sulphuric acid is added to convert the iron and nickel into sulphates, and the solution is evaporated to drive off the hydrochloric and nitric acids. The dry residue is then treated with water which dissolves the two sulphates, but leaves behind a small quantity of insoluble sub-sulphate of iron.

4th operation.—The iron is now precipitated by the addition of carbonate of baryta, which separates the iron in the state of sesqui-oxide, separating at the same time a sulphate of baryta, but not acting on the nickel. The last remaining traces of arsenic are precipitated with the iron.

After this last reaction, the sulphate of nickel alone remains in solution; the precipitate is separated by filtration, and the liquor should then be evaporated until a pellicle begins to form upon its surface, when the pure sulphate of nickel may be obtained by crystallization.

This mode of treating the nickel of commerce is more rapid and more economical than that followed up to the present time. It possesses some interest for the nickel-plating industry which has of late assumed important dimensions, and even for the coinage of money having nickel for its base. [*Moniteur Scientifique* vi, 560.]

CENTENNIAL NOTES.

Ridge's Gates for Railroad Crossings.—(Machinery Hall, D–65.) In the accompanying cuts, Fig. 1 represents a top view of a gate for railroad crossings; Fig. 2, a sectional side elevation of the same when thrown up; and Fig. 3, a side elevation showing it folded down to a level with the track for the passage of vehicles. A, represents the railroad track which is arranged at both sides of a crossing, with gates, B, which connect by a shaft passing under the track, to which is keyed a side lever handle which is operated by the flagman or other attendant. Each gate, B, folds into a recess or cavity of the ground of suitable depth and width in such a manner that the broader top piece, B, of the gates closes the cavity and prevents thereby the entering of dirt or other obstructions. These gates are thrown into position on the approach of a train, for preventing the passage of vehicles or persons over the track, by throwing the lever over in one direction, which raises the gates. These are folded out of the way after the train has passed, by turning the lever in the opposite direction.

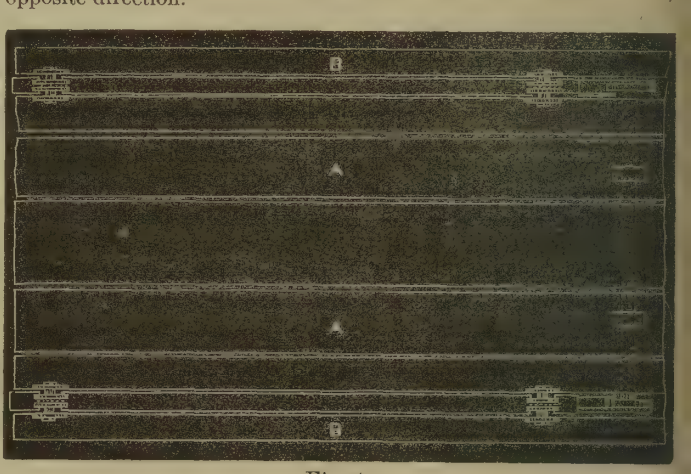


Fig. 1.

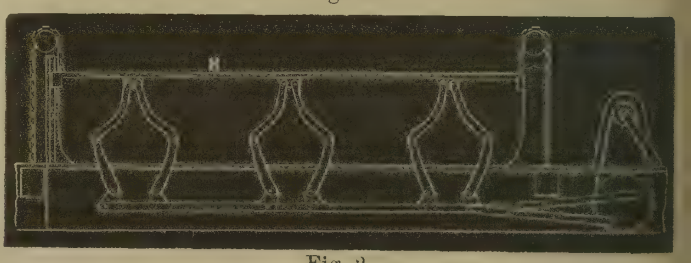


Fig. 2.

Fig. 3.

A Flange Cleaner by Temple & Miller, of Fredericton, N. B., is attached to the side of the cow-catcher.

Massey's Steam-Hammers have the valve motion actuated by a wiper fixed to the valve stem, and a pin on the guide plate or crosshead.

The Corticine Floor Covering Company of London, exhibit in the Main Building, through W. & J. Sloane of New York, some of the handsomest and most substantial of those floor coverings which, under the names of "Kamptulicon," "Linoleum," etc., have been brought out in the last ten years or less.

A New Method of Preparing Clichés for Music with the aid of Photo-Lithography. M. Alissoff, of St. Petersburg, Inventor.—"At the present time, there are two processes in use for the prepartion of plates in the printing of music.

The first is like that used for the production of *clichés* for books, that is to say, the different signs or types used in musical typography, have to be set one after another, so as to compose a complete musical stave. As each sign, however, is divided into several characters, this work is so long, and requires in the compositor so much practice and attention, that a *cliché* for music prepared according to this process is always very expensive.

The second process consists in engraving the notes on soft metallic plates. Although this is greatly facilitated and simplified by the use of special tools and punches, it requires in the engraver a particular skill—only to be acquired by well nigh life-long labor. And yet, even in the hands of the most skillful engraver, it progresses very slowly, as mistakes can only be avoided by the most extraordinary attention. It is difficult to correct minor errors, and those of greater importance—as, for instance, an omission, or a defective arrangement of the bars, is irreparable. In that case, there is no alternative but to begin the whole page over again.

The composing process I employ for the printing of music greatly simplifies and accelerates the work.

It may be described as follows:

Firstly, the staves, notes and other signs used in music, are printed on very thin unsized paper, and arranged in type-cases like ordinary metallic types. This done, the composition is set by simply pasting, first the staves, then the notes and signs, on a sheet of glass, in accordance with the manuscript which is to be printed. These different characters have to be affixed to the glass with a gum which has the property of rendering the paper transparent. As a guide to the compositor, I place on the opposite side of the glass a sheet of paper, ruled closely with vertical and horizontal lines, with the aid of which it is very easy to space the bars properly, and to dispose the notes and musical signs on the staves with perfect regularity. Moreover, the characters made use of, being three or four times larger than ordinary musical signs, may be handled with great facility. When a page is set, the ruled sheet of paper is removed from the glass, and by means of photography, (letting the light pass through the composition,) a negative is taken, reducing the page to the desired size. From this negative it is easy to transfer the composition to stone, and to print, according to the usual photo lithographic process, any number of copies required.

Should *clichés* be wanted, the composition would have to be transferred to zinc plates, prepared according to the ordinary method of helio-engraving.

The advantages of this process are the following:

1. The work of composition for music is simplified to such a degree that no special compositors or engravers are needed; any one, even a child, may do it, after having but once seen it done. I may even say it is no longer a man's work, but rather a woman's.

2. When composing, any correction whatever may be made with remarkable facility and rapidity; the composer has but to unpaste the little piece of paper on which the error has been made, and he is thus under no necessity of beginning the whole page over again.

3. With the same composition stereotypes of any size whatever may be obtained.

4. A page of music printed by this process, far from being less perfect, is even superior to one printed by the ordinary method.

5. A person establishing a printing office according to my plan, will avoid the considerable expense commonly incurred in the purchase not only of a stock of metallic signs and characters, but also of engravers' tools and punches.

6. This process may be used with success for the printing of titles in fancy letter, and ornamented with vignettes; and even for the printing of all names and words of maps and plans."

The details of the process may be thoroughly inspected in the Russian Department, Machinery Hall, United States Centennial Exhibition.

A New Ice Machine.—M. Pictet, (Pump Annex) employs anhydrous sulphurous acid, which is liquid at atmospheric pressure, under —10° C.; and at 35° C. does not give pressures above four atmospheres; does not act on metals or fats; is not combustible or explosive. The machine will receive full and detailed description in our journal.

The Sutro Tunnel is shown very clearly in a sectional model of considerable size, exhibiting the general topography of the surrounding country, and the location and direction of this great engineering undertaking. The model is made by Rowland Jordon of London, and is shown in the space of the Burleigh Rock Drill, Machinery Hall, south aisle.

Franklin Institute Centennial Reception Room.—The Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, has, through the kindness of the Centennial Commissioners, a Reception Room at the north-western end of Machinery Hall, for the use of its members and visitors from abroad, interested in the Mechanic Arts. The Institute cordially invites all who desire to do so to visit this room, in which will be found files of the Journal of the Institute and of other periodicals devoted to the Industrial Arts. The room is in charge of a Committee ot thirty members of the Institute, one or more of whom will be in attendance daily, during the exhibition, to receive visitors and give any information they may desire in reference to the exhibition.

The following objects of great historical interest, have been placed in the room:

1st. *Franklin's Electrical Machine.*—This instrument is doubtless the one used by the great philosopher in making his wonderful experiments in the science of electricity. Presented to the Institute by Dr. John R. Coxe.

2d. *Oliver Evans' Steam Locomotive Engine.*—This interesting model is among the earliest known, having been built about 1804.

3d. *Oliver Evans' High Pressure Steam Engine.*—This is the model of an engine built by O. Evans, about 1804, and is described in Galloway's work on the Steam Engine, page 101.—London, 1827.

4th. *Working Model of a Steam Engine* built by M. W. Baldwin, and presented by him to the Institute, about 1832.

The Chairman of the Reception Committee is Mr. J. E. Mitchell, whose courteous and hospitable disposition does much to promote pleasant relations between the Institute and foreign societies.

Cloth Cutting Machines.—In our June number we described two cutting machines; one with a reciprocating chisel, the other with a rotating circular knife. A third has a rapidly traveling endless band knife, and is here described:

Sanson's spring-arm, endless band knife, cloth cutting machine cuts from 2 to 4 inches thick. The upper arm has spring, by which the running of the band knife is avoided; and the gap is very deep. In British Section, Machinery Hall.

The Gum Stickem Pavement has gone from bad to worse. It has only one redeeming feature—if you cut your monogram or some other trade-mark in the sole of your boot, your friends can track you all over the grounds, unless the travel is too great. This pavement is not asphalt, but it is *as fault-y* as could be.

Edoux' System of Ascending Steep Mountains is shown against the east wall in the French Department, Machinery Hall. It comprises a series of hydraulic lifts and short horizontal tracks, by which a railroad car is raised a certain distance, rolled to the foot of the next lift, and thus "taken up stairs" to the summit. The idea is one of the wildest in the exhibition.

A Telescopic Trestle, by M. E. Dailey of Ottawa, Canada, has a firm brace with telescopic standards adjustable to various heights by pins. The top is also extensible.

MISCELLANEOUS.

Origin of Fires.—Out of 585 fires and alarms in the City of Philadelphia during 1875, 29 are ascribed by Chief Johnson to spontaneous combustion; 20 to matches; 14 to boiling over of combustibles (varnish, &c.); 35 to explosions of coal oil lamps, 19 to careless using of lamps and oil; 3 to explosion of coal-oil tanks, and one to coal-oil in creek; gas and gas-jets are credited with 20; defective flues with 39, and foul chimneys with 17. Fireworks caused 29; hot ashes, 17; sparks, 67; overheated stoves, 25. To these causes enumerated are due 335 fires and alarms, or over 57 per cent. of the entire number. There were 27 incendiary, 11 supposed incendiary, and 58 "unknown," among which last we may credit the causes enumerated above with a liberal share, sufficient to raise their percentage to over 60 per cent. of the entire number.

Pooley's Weighing Machines.—A very ingenious device for weighing by any one of three or more systems of weight, consists in having the graduated portion of the weighing arm a hollow prism revolving on a longitudinal axis, and having as many angles as there are systems of graduation required; whichever graduation is to be used is turned up. [Ill. in *Engineering*, xxi, 492.

Physical Constitution of Steam.—Jas. J. Murphy, in *Nature*, states his belief that 872·7° C. is the "critical temperature" for water—where the difference between the gaseous and liquid states no longer exists.

Snapping of a Fly-Wheel at Night—The Engineer (xli, 397) records that a 3-ton fly-wheel, 9-ft. drain, cast in one piece, and worked for years, was laid horizontally on two balks of timber, and fractured in several pieces during the night. The sun's rays had heated the rim, and the arms contracted too rapidly for the rim.

Lieutenant Cameron at the London Institution.—The theatre of the above institution was crowded to the doors on Monday afternoon, to hear Lieutenant Cameron describe his journey across the Continent of Africa. The lecturer commenced by stating that he should not trouble the audience withthe particulars of the first part of his journey, of which he had already given details at the Geographical Society's meeting. He found indications of civilization in many places. At one village where the men were all iron-founders and smiths, the huts had some architectural pretensions, and were surrounded by regularly-planted groves of palm trees, four huts being situated within each grove. Coming to the great river Lualaba, the lecturer warmly eulogized the surrounding scenery, and added that it was studded with inhabited islands. One of these islands was a great oyster market, often attended by seven or eight thousand people. The people had ivory and various natural products to dispose of, but they would exchange them for nothing except slaves, alleging that in any other traffic their capital would remain too long unproductive. Having at last reached the shore of one of the lakes, he had the opportunity of seeing a sort of Congress of native doctors, who went about each with a row of iron bells hung over his loins, which he kept perpetually ringing to attract patients. Like doctors elsewhere, those eminent physicians were very solicitous about their fees. The lecturer went on to describe with considerable humor a royal levée at which he had the honor of assisting, and after which he proceeded on his journey in a south-south-west direction. He passed over symptoms of coal formations similar to those which existed in England previous to the period when we commenced working the mines. A portion of the country through which he passed was the loveliest in the world. In parts it resembled the Wiltshire Downs, and in others the park-like scenery of the Midland counties of England. He saw this during a forced march of 130 miles in five days to the coast. In conclusion, Lieutenant Cameron stated that nearly the whole of the country through which he had passed was unsurpassed in the richness of its fertility. It abounded in mineral products, in ivory, in palms, in palm oil and in other valuable articles of commerce. The hideous blot of the slave trade, however, darkened the whole of this beauteous scene, and the only way of abolishing that trade would be to open extensive and easy means of communication with the interior, a thing which could be easily done by cutting a canal of between twenty and thirty miles in length between the Congo and the Zambesi. That once done, they would have uninterrupted communication from the west to the east of Africa. [Iron vii, 587.]

Chameroy's Weighing Machine.—The Society of Civil Engineers at Paris received a communication concerning a steelyard, which is made to record the weight by printing it on tickets. At suitable distances on the under edge of the beam is a series of punches; a movable plate is inserted in the sliding weight below the beam, and capable of being brought into contact with it by a lever. The ticket is introduced between the plate and beam. [Abr. from *The Engineer*, xli, 401.

New Use for Colored Glass.—At a recent meeting of the Brussels Entomological Society, Mons. Capronnier called attention to the efficacy of certain colored glasses in preserving the bright hues of specimens, especially the green and carmine hues of *lepidoptera*. Yellow glass preserved for 90 days, in strong daylight, colors which faded and changed under other colors in half that time.

Setting Milk.—The prevailing opinion now seems to be in favor of deep setting, accompanied by refrigeration.

Water Proof Paper Bags are proposed, to be made by making a long flattened paper tube, to be run between rollers, and thus saturated with a water-proofing material composed of tallow one or two parts, rosin 100 parts, dissolved in naphtha; the tube to be cut in suitable lengths and the bag-bottoms closed.

The Mexican Onyx.—The beautiful slabs, mantlepieces, table-tops and the like, of "onyx" of Tecali, which are so much admired in the Mexican department of the exhibition, has been examined by M. Dancour, and found to consist chiefly of the carbonate of lime, with some ferrous and manganous oxides, and a trace of silica. It varies in color from milk white to pale green, certain samples displaying brown veins shading into red. The material takes on a fine polish, and affords objects of great beauty.

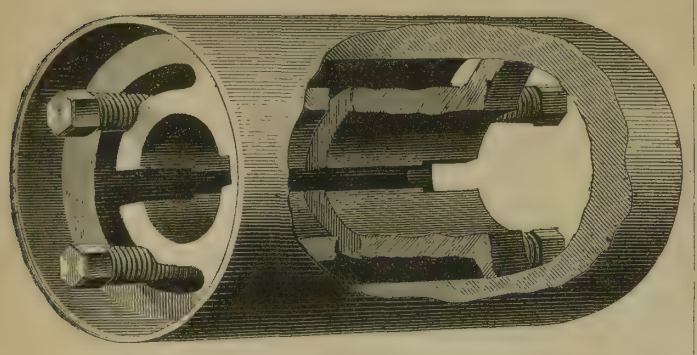
The lighting of London is effected by 54,000 lamps, consuming 3,000,000 cubic feet of gas per day, at a cost of £250,000 per year. [*E. & M. Jour.*]

Demand and Supply in Invention.—Demand having arisen for long and powerful coiled springs for driving tramway cars, remarkable results have been attained. A band of steel has been rolled, which will give a draft of 3000 lbs. Another band has been rolled, 4 in. wide, 184 ft. long. [Abr. from *Sci. Am.*, xxv, p. 15.]

Cause of Glacial Epochs.—Mr. John Hepburn, of Gloucester, N. J., ascribes the glacial epochs to the earth's (asserted) motion at right angles to the plane of her equator.

COUPLINGS AND PULLEYS FOR SHAFTING.

I.



"CRESSON" PATENT INTERNAL CLAMP COUPLING FOR SHAFTING.

(*Machinery Hall, C–71 to 73.*)

The various styles of Shaft Couplings may be divided into two distinct classes:

Firstly, those that are rigid and have a *non-adjustable* hole for the reception of the shafts.

Secondly, those that are cut or divided lengthwise in the direction of the shaft axis, thus rendering the hole *adjustable.*

In the first class are the *Sleeve Coupling* and the *Flanged or Plate Coupling*, and also a number of others, that, however, differ only in unessential particulars. Although the couplings of this class can be made to unite shafts firmly together, they labor under the great disadvantage of requiring skilled labor to make accurate fits, both in the turning of the shaft-ends and in the fitting of the keys by hand, and whenever they have to be removed they give considerable trouble. If they are not fitted very accurately, they are then apt to cause the shaft to work its way out of the coupling. Loss of life and damage to valuable machinery may result from apparently trifling, but practically, uncontrolable neglect in the fitting of these couplings.

To improve upon these couplings and to overcome some or all of their disadvantages and defects has long been the task of many intelligent engineers and millwrights. The results of their efforts will be found in the second class, where one must distinguish again those couplings that are *merely cut lengthwise* (once or twice,) from those that, besides being thus cut, have also a *division transversely.*

The couplings that are cut only lengthwise (being fastened on the shaft either by bolts passing through them or by rings driven or screwed upon their outside,) although they have the advantage over the couplings of the first class, in that they can be applied or removed without much difficulty, and need no hand work on the keys, *still they all lack one feature, indispensable in a good coupling, which is a reliable and uniformly powerful hold upon each shaft-end;* and it makes no difference in which form they appear. The reason why this feature cannot be obtained in these couplings is, that in spite of employing the best mechanics and good machinist's tools, we are not able to turn two shafts of exactly the same diameter. Hence only the larger shaft will be clamped firmly, while the smaller shaft can only receive a hold at the outer end of the coupling. A difference in the diameters, of 1000th part of an inch is sufficient to produce this effect. Therefore these couplings are as liable to work loose and cause trouble as inaccurately fitted Sleeve or Plate Couplings. A fact well-known to all experienced millwrights.

It will be obvious, therefore, that a *perfect coupling must be so arranged that the practically unavoidable differences in the diameters of the two shaft-ends cannot influence the uniformity of the coupling-grip upon either shaft.* This we obtain by adding to the lengthwise cut a transverse division in the middle of the coupling, where the shafts meet, and by surrounding the parts thus cut and divided by a strong sleeve.

A very simple and powerful coupling constructed in this manner is the "Internal Clamp Coupling," shown in the above illustration, where it has been partly broken in order to show the transverse division in its interior.

This coupling is cast in one piece with two separate pairs of clamps formed therein. In the cored openings between these clamps and the outer sleeve there are inserted, in places properly prepared therefor, taper screws, which when screwed down will cause a closing of the clamping parts towards the centre of the coupling; or if the coupling be on shafts, would produce a pressure thereupon. The pressure thus obtained is theoretically only upon three lines of the shafts, but as the hole is always made slightly smaller than the shafts, *there is obtained a uniformly distributed pressure upon nearly the whole surface of each shaft-end.* It is further evident that, by selecting for the screws a fine thread and slight taper, we are enabled to force the clamps down to a powerful hold on each shaft, fully equal to a forcing fit; and as the action of each screw is perfectly independent one from the other, it is unimportant whether the shafts are of exactly the same or slightly varying diameters.

There are other couplings which share with the Internal Clamp Coupling the features of the lengthwise cut and the transverse separation, but those couplings are complicated in construction and expensive to manufacture, have a very limited clamping power, which besides is obtained by submitting the bolts to a severe tensile strain, which may cause them to break or the nuts to strip off. The nuts furthermore are liable to work loose, and the removal of these couplings, if they have been exposed to moisture for some time and are consequently rusted, becomes very troublesome.

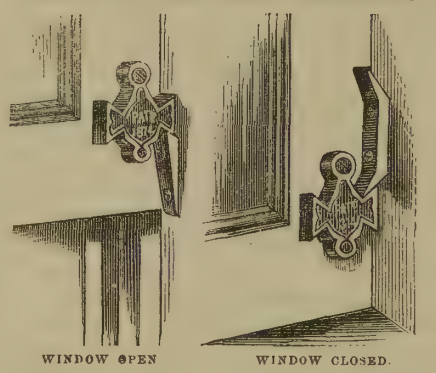
Subjecting the *Internal Clamp Coupling* to criticism, one must acknowledge that it has none of the defects of other couplings, but that it offers great advantages in every respect. *It exerts in the most reliable manner the greatest desirable clamping power upon the shafts. None of the adjusting parts are exposed to any strain, or liable to be broken, work loose or rust fast. It can be erected or removed in a few minutes, there being but one piece to handle.*

For coupling shafts of different sizes it is convenient to employ a *Reducing Internal Clamp Coupling*, made with two different bores, whereby the full strength of the larger shaft, for its entire length, is preserved.

Experience and thorough tests have given the proof that the Internal Clamp couplings, even if applied to the heaviest work under the most unfavorable circumstances, will always hold the shafts firmly together and give full satisfaction. They are in operation by thousands not only in the United States, but also in England, France, Belgium, Germany, Austria and Canada, where they are manufactured by prominent millwrights.

(*To be continued..*)

DIXON'S PATENT SASH FASTENER.



WINDOW OPEN WINDOW CLOSED.

Above is given an engraving of a very neat, as well as simple and effective, sash fastener, exhibited in Machinery Hall. Patented by F. E. Dixon of Toronto, Canada.

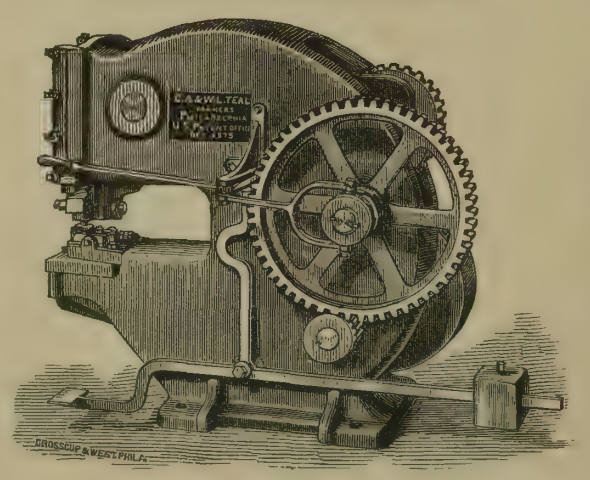
The large piece, which somewhat resembles a Maltese cross in shape, is fastened to the sash on either side by a screw, which is driven in just so far as to allow the fastener to swing freely from side. A piece of metal similar to that shown in the right hand cut is screwed to the side of the frame close above the fastener, which hooks itself underneath and prevents the window being raised from the outside. The top of this piece also acts as a support when the window is raised.

When opening the window, the fastener should be moved outwards with the finger; it will then swing itself past one or more pieces similar to that shown in the left hand cut, and it will immediately adjust itself on the top of any one of them, thus supporting the window at the desired height.

They seem remarkably well adapted for the windows of railway carriages.

These fasteners have a very large sale in Canada. The U. S. patent is for sale.

TEAL'S IMPROVED POWER PUNCH.



The above represents a new pattern of single punch, manufactured by C. A. & W. L. Teal, Philadelphia. The "head" is worked by a lever with jaws in the back end, which carry a cam-gear with "treads," one on each side of the teeth; underneath the cam and on the shaft of the large gear, is a pinion, with treads corresponding to those on the cam; as the pinion revolves, the cam rolls round upon it, the shape of the cam being such that about four-fifths of the circumference are employed in raising the lever, and the remaining one-fifth in dropping it, giving the head a slow downward, and a quick upward motion. The advantage of this will readily be seen, as the friction of the cam is rolling friction, except that of the pin on which it revolves; the motion being like rolling up an inclined plane. The bearings for the lever in the punch-head are provided with an arrangement for taking up the wear or lost motion, which avoids the necessity of repairing.

The die-seat is capable of very accurate adjustment with the punch; and for boiler-makers the machine is made small at the end on which the die-seat rests, for punching flanged heads, angle iron, &c. Punch stripper is also adjustible to any thickness of iron.

These machines are provided with a loose and a heavy fast pulley, and are made separately for punching, shearing plate and cutting off bar iron; and when desired, one machine can be furnished with attachments for all three purposes.

This machine is for boiler-makers' use, and will punch 1-inch hole in 1-inch iron, shear 1-inch plate and cut off 1½-inch bar iron, and will punch and shear in the centre of 42-inch plates.

In operation in Machinery Hall, column C–26. G.

BIBLIOGRAPHICAL NOTICES.

ON THE FRENCH SYSTEM OF WEIGHTS AND MEASURES, WITH OBJECTIONS TO ITS ADOPTION AMONG THE ENGLISH SPEAKING NATIONS; AND ON THE DUODENAL ARITHMETIC AND METROLOGY. By John W. Nystrom, C. E. Philadelphia, J. Penington and Son, 1876. 20 pp. 8vo.

The title of this little work is a complete misnomer, conveying the idea that Mr. Nystrom had been dealing the metric system some hard blows; whereas the insertion of the expression "*on the*" before the word "objections," would have indicated more nearly what Mr. N. has done.

The pamphlet is a very able consideration and refutation in detail of the various arguments, or prejudiced objections, against the introduction of the French metric system. Standing these objections up one by one, Mr. Nystrom knocks them down successively, with a sledge hammer effect that is really quite refreshing to those not attacked. Whenever Mr. Nystrom leaves the personal element from his discussions, they impress one very favorably with his learning, ability, and sound practical common sense.

This pamphlet is too short for abridgment, and is well worth reading. †

"HOW TO WRITE LETTERS."—A neat little work, entitled "How to Write Letters," by J. Willis Westlake, A. M., is before us. The author correctly says, in his Introduction, that letter writing is "the most important, practically considered, of all kinds of composition" Full instructions are given as to the structure of letters, the paper, envelopes, ink; the heading, etc., and the folding and superscription. A few rules on orthography are given; specimen letters of introduction, familiar and on business, are added. Due consideration is paid to the subject of punctuation. There is an excellent list of titles, to be used in addressing persons of different rank, one of abbreviations, and a collection of foreign words and phrases. This book should be in the hands of every pupil, and will be of great use to a large class in the community who need to know just what it teaches.

Published by Sower, Potts & Co., Philadelphia.

The American Chemical Society.—An organization of professional chemists has lately been formed having the above name, under the presidency of Prof. John W. Draper. The new society already boasts of a membership of over 100, including the most prominent chemists of the country. As an agent for fostering and promoting the development of chemical science in America, the society has a wide field of utility.

Mineral Wool.—At Krupp's works at Essen, Prussia, the following plan for utilizing furnace slag is practiced. The pig-iron furnace is provided with a tap an inch in diameter, out of which a continual stream of slag is allowed to flow and to fall a distance of 2 ft. 6 in., at which point the falling stream of slag is met by a strong blast of cold air, the effect of which is to separate the slag into myriads of hair-like threads as white as snow, resembling the finest wool. These fibres, like spun glass, if handled, will penetrate the skin. The mineral wool is used for packing steam-pipes, boilers, etc., and is a valuable product. [*Practical Magazine*, vi, 170.] This product is not a novel one. The same substance for which a U. S. patent had been granted, was exhibited by the writer at one of the meetings of the Franklin Institute, in 1871. Two years later, it was announced as one of the novelties of the Vienna Exhibition.—*Ed.*]

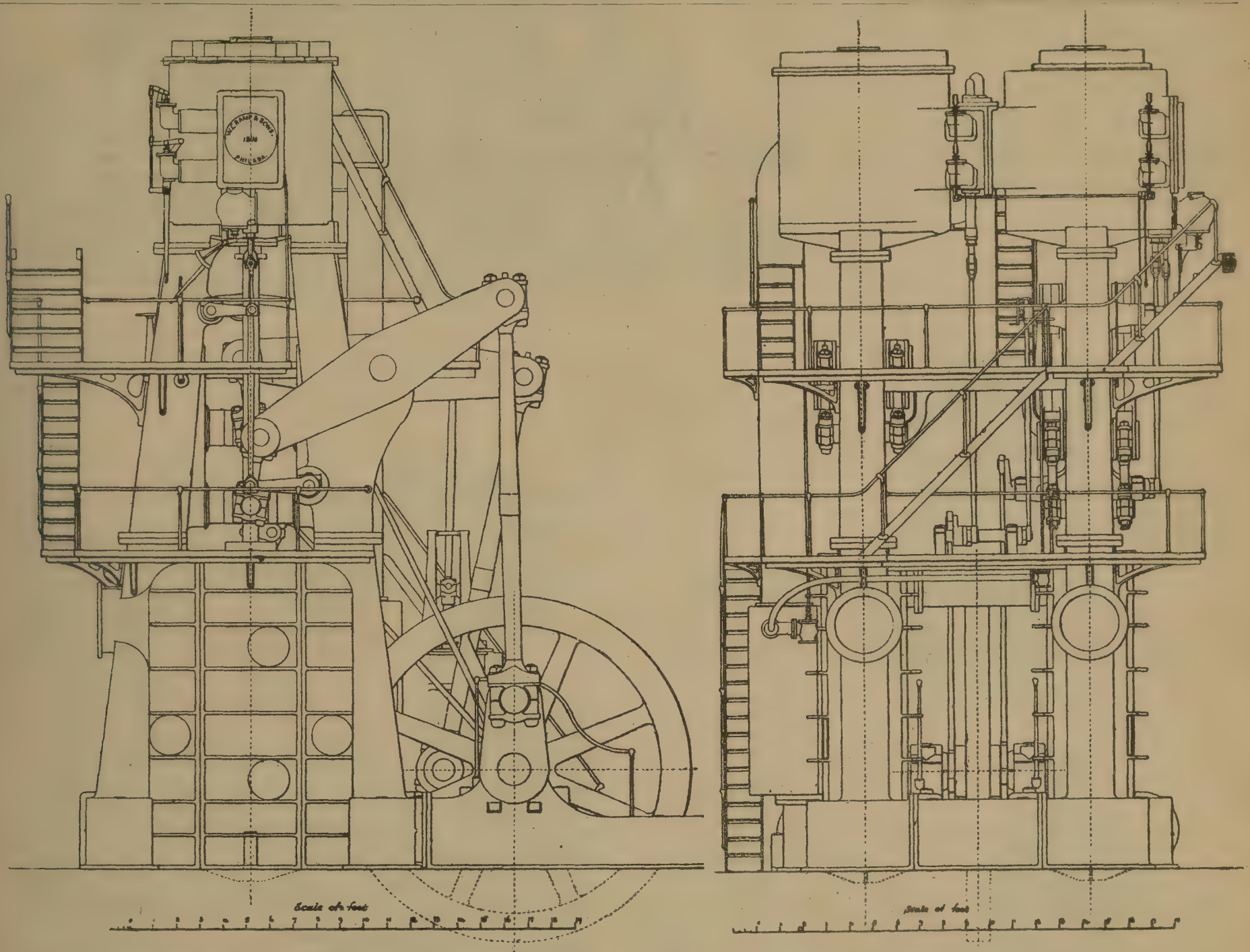
An "Improved" Lamp Chimney has a hole in the side, through which to light the wick, and which is closed by a sliding disk. [Illust. in *Sci. Am.* xxv, 22.]

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, JULY 22, 1876 NO. 3.



"TWENTY MILLION" STEAM PUMPING ENGINES FOR SPRING GARDEN WATER WORKS.

DESIGNED AND BUILT BY THE WILLIAM CRAMP & SONS' SHIP & ENGINE BUILDING COMPANY, PHILADELPHIA, 1876.

The accompanying engravings and specifications illustrate a pair of steam pumping engines recently constructed for the Water Department for the City of Philadelphia.

Two (2) double acting, vertical, plunger pumps, with a combined capacity of twenty (20) millions of gallons per twenty-four (24) hours; arranged to be driven by an engine of the independent compound type, with two (2) inverted cylinders, placed over the pumps and operating direct a crosshead placed below each cylinder.

The rods of the pumps and of the steam pistons to be attached to the crossheads, which work in guides, and the crossheads to be connected by links to wrought iron beams which will be supported at their centres by bearings cast on the housings that support the cylinders. At the ends of these beams, opposite to the cylinders, connecting rods unite them to cranks on a shaft that revolves in the bed plate. These cranks are placed at right angles to maintain a uniform motion, and a fly-wheel is fastened on the shaft to assist the engines over their centres.

To each cylinder a plain slide valve is attached, operated by eccentrics, and an adjustable cut-off valve works on the back of the high-pressure valve; it obtains its motion from the rock shaft of the low pressure engine. The condenser and air pump are fastened to the pump under the low-pressure engine, and the air pump is worked direct from the main beam.

Relief valves are attached to each end of each cylinder and arranged to be worked by hand for starting up the engines. A safety-valve is attached to the receiver between the two cylinders, to prevent any undue pressure accumulating at any time.

Pumps 30 in. diameter by 6 ft. stroke of plunger.

High-pressure steam cylinder, 40 in. diameter; low-pressure steam cylinder, 80 in. diameter; both with a stroke of 6 ft. The high-pressure cylinder to be enclosed in another cylinder of the same diameter as the low-pressure cylinder, the space between forming part of the receiver.

Duty guaranteed of 75,000,000 foot-pounds upon 1 cwt. of combustible. Water to be forced to a height of 130 ft. through 2000 ft. of 48-in. main.

From the annual report of the Chief Engineer of the Water Department for the year 1875, the largest average amount of water pumped per day by all the works was 51,249,917 gals., in the month of June, and the smallest, 32,726,396 gals., in the month of January. Two engines like the above, when worked up to their full capacity, will be sufficient to supply the entire City of Philadelphia with water.

COMBINED SUSPENSION BRIDGE AND TUNNEL.

It will be remembered that some few years ago there was a company chartered for the purpose of connecting Philadelphia and Camden by a suspension bridge across the river Delaware. Of this company, Mr. Thos. S. Speakman was the originator, Mr. J. H. Linville (President Keystone Bridge Co.) Consulting Engineer. A portion of the stock had been paid in, when, through complications arising out of the panic of 1873, the project rested. The charter recently expired through limitation. Mr. Speakman has now a project for crossing the Delaware at the same point by means of a bridge over the shallow portion of the river; the west channel being left free to navigation by carrying the line of travel through a subaqueous tunnel.

The engineering details and estimates are not yet ready for publication; but when prepared for public notice, will appear first in this journal. G.

IMPROVED PORTABLE STEAM ENGINE.

ADAPTED FOR BURNING STRAW, COTTON AND MAIZE STALKS, REEDS, TIBEN, ETC., AS WELL AS COAL OR WOOD.

This engine is the joint invention of Mr. John Head, of the London firm of Ransome, Sims & Head, and the late Mr. Schemioth, a Russian engineer.

By means of the apparatus, any description of fuel can be burnt, and consequently steam can now be used as a motive power in countries where vegetable products, such as straw, reeds, cotton and maize stalks, sugar-cane, refuse, etc., are abundant, but where coal and wood are not easily obtained except at a very high price. The apparatus is self-acting, and driven from the engine by means of a strap. It can easily be disconnected from the boiler and the ordinary fire-door substituted in its place, in cases where it may be expedient to burn wood or coal. Steam may be got up with straw as easily as with any other combustible, by attaching a handle to the feeding rollers, and turning them by hand instead of steam-power. One man only is necessary to feed the straw into the machine; and an engine of this description does not require any more men to superintend it than if coal or wood were used as fuel.

A number of these engines have been at work for some time in Russia and other countries burning straw, and have given the utmost satisfaction; they have also been used in Egypt with cotton stalks, and in India

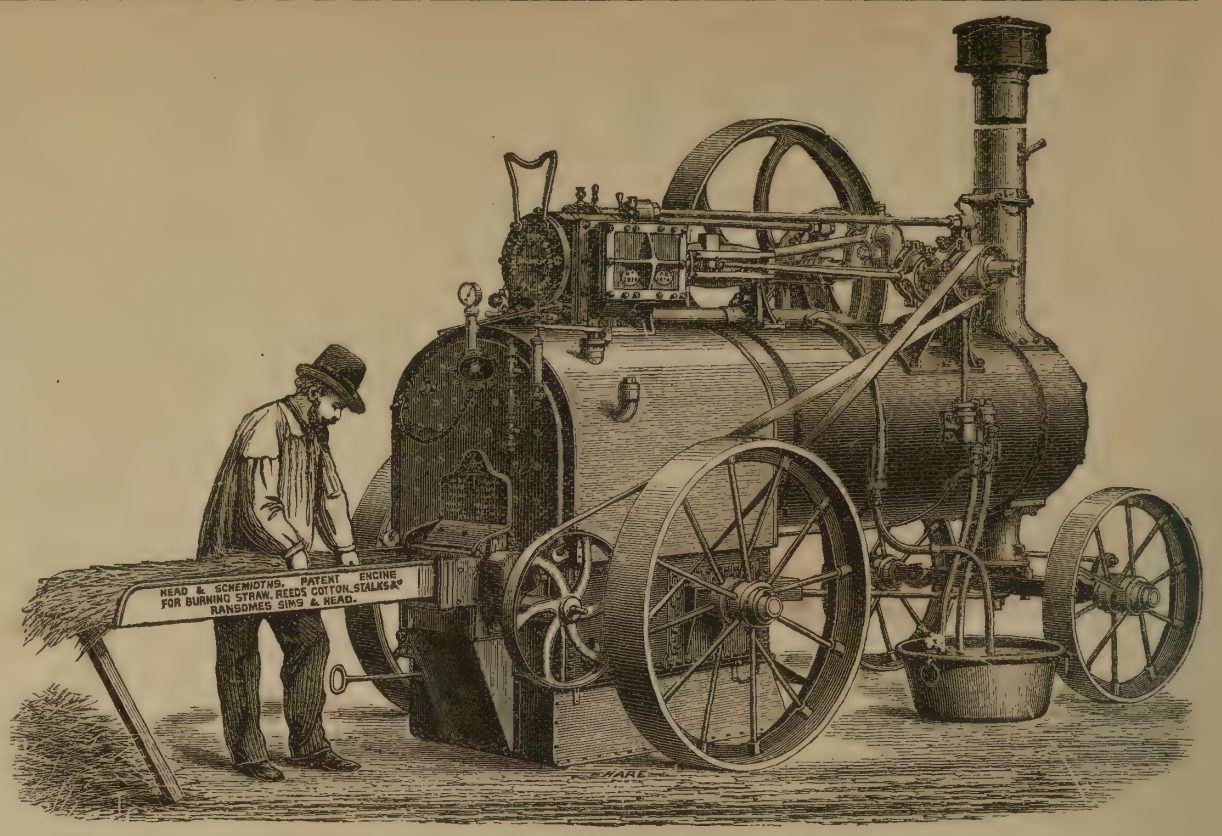


Fig. 1.

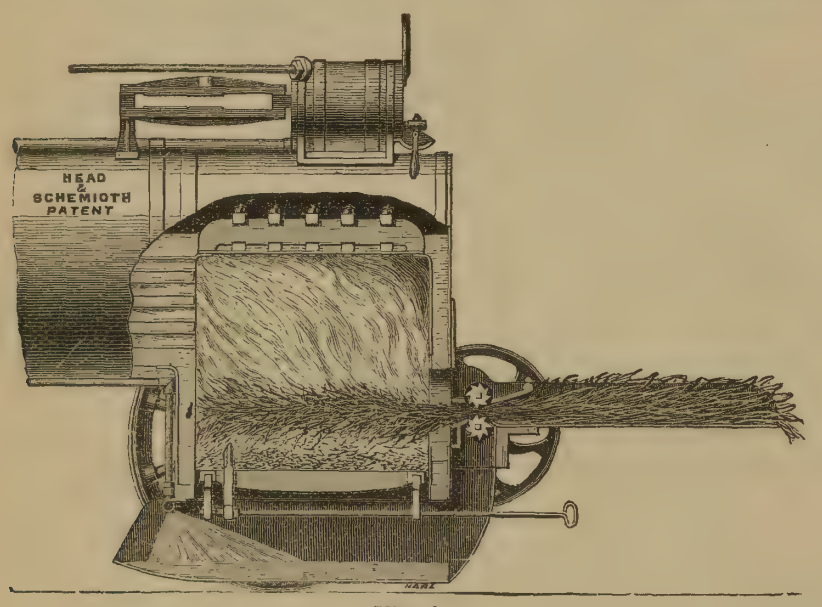


Fig. 2.

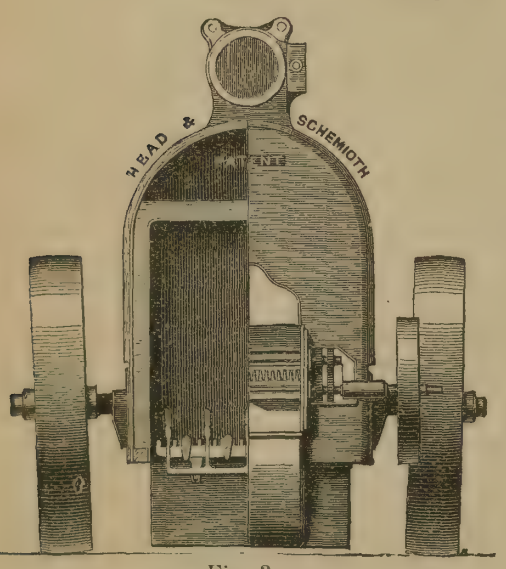


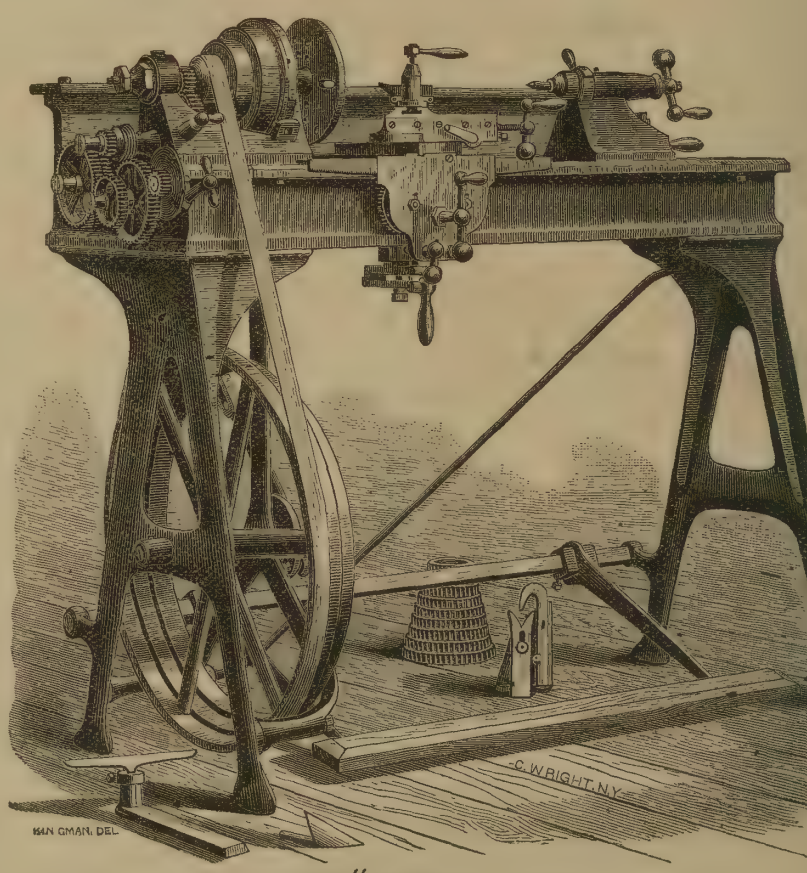
Fig. 3.

with indigo refuse as fuel, and in both cases with the most successful results. By means of this apparatus small branches of trees, twigs and furze can also be employed as fuel.

Of the cuts given, Fig. 1 shows a general view of the apparatus under steam, with the feeding apparatus worked by a belt from the crank shaft. Fig. 2 shows a section through the fire-box. Fig. 3 gives an end-view of the rollers and fire-box.

The theoretical principle is to burn straw, reeds and other similar vegetable substances by means of a self-acting mechanical arrangement, which continually forces the straw, etc., into the fire-box, in the form of a fan, holding it in suspense there, so that each piece is subjected to the action of the flame and no impediment is offered to the ingress of a sufficient amount of atmospheric air. At a trial in Vienna, a 10-horse power engine was use for the experiment, making 140 revolutions per minute, and the brake was loaded for a duty of 19-horse power. 355lb of straw was carefully weighed, consisting partly of straight rye and partly of loose broken wheat straw, purposely mixed, in order to test the capabilities of the engine for burning all kinds of fuel of this description. It required 46 minutes to consume the straw, steam being kept up during the whole time at a pressure of 70lb per square inch with the greatest regularity. This result gives a consumption of about 24·5lb of straw per horse power per hour, and, as an engine burning average coal under similar circumstances would have required about 6·4lb. per horse power per hour, it appears that rather less than 4lb of straw are equal to 1lb of coal. In thrashing, about nine sheaves of straw are required to thrash 100 sheaves of wheat or barley.

As regards Messrs. Head and Schemioth's apparatus, of which we have already had occasion to express very favorable opinions, we are glad to learn that it is doing excellent work on the Continent. It is stated that during the late harvest of 1874, a number of engines fitted up on this plan have been in use on the banks of the Danube and in Russia, and have effected a mean daily saving of four ducats in Wallachia and Moldavia, and fifteen roubles in Russia, or about $10 per day, as compared with engines burning wood or coal.



THE "CORNELL" LATHE.

The amateur foot-lathe, illustrated in the above cut, shown among the exhibits from the Cornell University Machine Shop, at B, 68, Machinery Hall, is characterized by many novel features. Besides being fitted with rests for using the ordinary hand tools, it has a compound slide rest for turning and boring at all angles, set by a graduated scale, turns balls and sockets perfectly, cuts screws, feeds by hand or automatically, and possesses about twenty novel features in construction, which can be much better understood by an examination than from a description.

One novel feature, sound in both theory and practice, is the pivoting of the foot stock leg to the bed in such a manner that setting the lathe upon an uneven floor does not bring torsional strain on the bed.

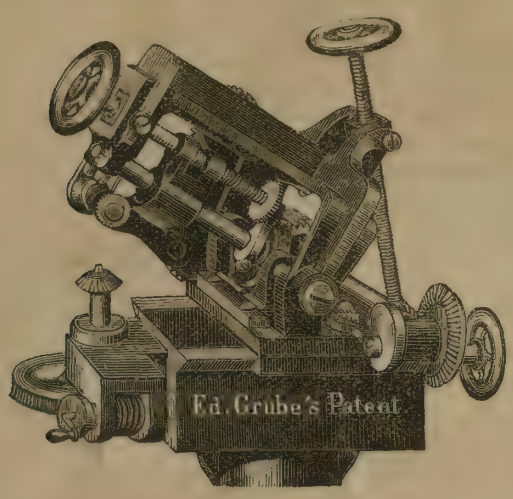
In this lathe, as in the other work shown in this exhibit, all strains are resisted by straight lines, and evidently a persistent determination to resist the American tendency to polish and ornament has been exercised, while the working parts are absolutely correct. Every one interested in such a tool is advised to examine its different features, and what is something of a rarity in exhibitions, instead of visitors being requested to stand back, they are at liberty to handle it to their hearts' content. Prof. Sweet says: "Their work is made for use and not to look at, and that if the tools will not stand the usage of an exhibition, they are not fit for a workshop." Surface plates and straight edges, which most people would put in a glass case or lock up in an office, are placed where any one can handle and test them.

We will refer to other exhibits shown at this stand in a future number.

GRUBE'S BEVEL WHEEL CUTTER.

GERMAN SECTION, MACHINERY HALL.

This a device for cutting bevel, spur and worm wheels. (The cut shows it separated from its iron base.)

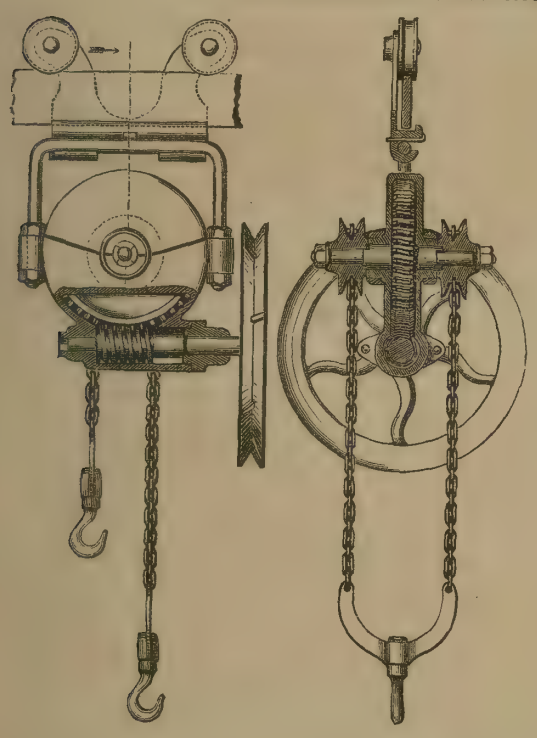


In front of and under the bed-plate is a worm-wheel of 120 teeth; on the spindle of which, prolonged above the bed-plate, is chucked the wheel to be cut. The cutter-frame is movable in the longitudinal vertical plane, being hinged at the back and adjustable by a hand-wheel at the rear. This brings the cutter into the required angle to the pitch-line or bottom of the wheel; the angle being indicated on an index plate.

The milling cutter rotates on a horizontal axis, and is vibrated in the plane of the rear bevel-face; it has an upward and forward screw feed. The reciprocating motion necessary to give the vibration corresponding with the convergence of the tooth-faces, is adjustable by a screw and radial slot; and by the same mechanism an adjustable pawl gives to a ratchet-wheel on the feed-screw, engaging with each successive tooth, or passing each fourth tooth, as desired. The cutter is driven by chain-gearing. To cut spur wheels, the side motion is removed, and the cutter placed vertically; to cut worm-wheels, the cutter is inclined. The index wheel gears with a worm, on the head of which may be placed any one of three "division-rings" by means of which 60 different divisions may be made, without change-wheels. The weight of the machine (including the iron standard and base) is 205 kilog. (450 lbs.); it cuts bevel-wheels under 45° up to 140 mm. (5½″); spur and worm wheels up to 400 mm. (16″) diameter.

G.

PENNYPACKER'S HOISTING APPARATUS.



The above cut represents a hoisting apparatus, intended to be used either as a traversing hoist, when suspended by wheels on a rail or beam, or by detachment therefrom, be used as lifts at any desired point. It consists of a central box, affording bearings for a wheel carrying winding sheaves on its opposite sides, over which a double winding chain is applied. By the direct attachment of the chain wheels, by means of clutches and a clamp bolt, shaft and keys are dispensed with.

The inventor's claims are: "The use of the double chain for heavy lifts obviates the necessity of the use of the large chains that are now required when it is desired to obtain strength of section; presents double amount of wearing surface on the chain and sheaves, equalizes the load on its bearings—thereby reducing friction, preventing unequal and indirect wear and strains, and greatly increases the strength and durability of the machine. It is safe, durable and cheaply constructed. The screw revolves in a chamber full of oil. It will sustain its load at any desired point."

For further particulars, address M. Pennypacker, Baldwin Locomotive Works, Philadelphia.

THE MECHANICAL ACTION OF LIGHT.

A Lecture delivered at the Royal Institution, London.

BY W. CROOKES, F. R. S.

III.

The second question, namely, "What influence has the color of the surface on the action?" has also been solved by this apparatus.

In order to obtain comparative results between discs of pith coated with lamp-black and with other substances, another torsion apparatus was constructed, in which six discs *in vacuo* could be exposed one after the other to a standard light. One disc always being lamp-blacked pith, the other discs could be changed so as to get comparisons of action. Calling the action of radiation from a candle on the lamp-blacked disc 100, the following are the proportions obtained:—

Lamp-blacked pith	100
Iodide of palladium	87·3
Precipitated silver	56
Amorphous phosphorus	40
Sulphate of baryta	37
Milk of sulphur	31
Red oxide of iron	28
Scarlet iodide of mercury and copper	22
Lamp-blacked silver	18
White pith	18
Carbonate of lead	13
Rock-salt	6·5
Glass	6·5

FIG 8.

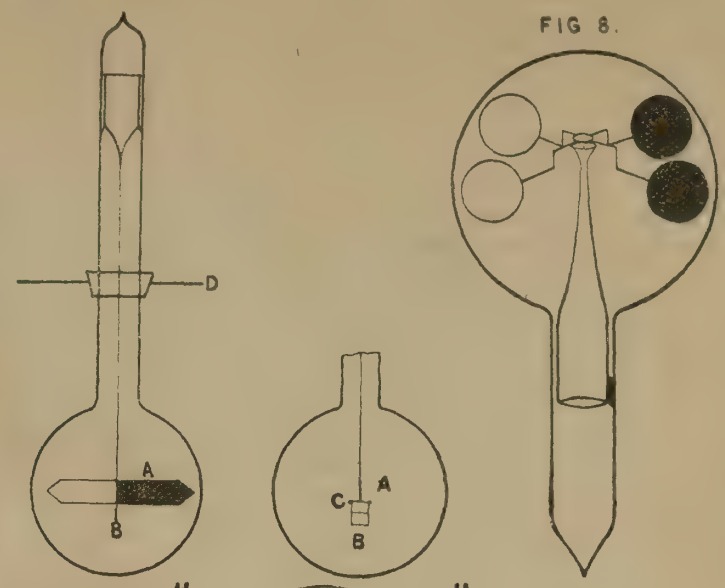


FIG. 7.

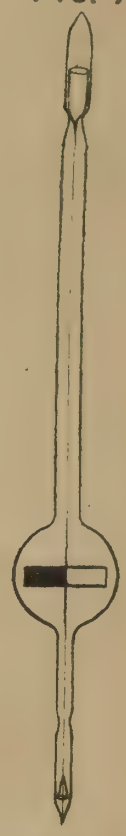
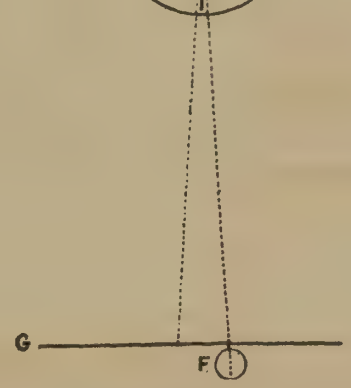


FIG 6.



This table gives important information on many points: one more especially—the action of radiation on lamp-blacked pith is 5½ times what it is on plain pith. A bar like those used in my first experiment, having one-half black and one-half white, exposed to a broad beam of radiation, will be pushed with 5½ times more strength on the black than on the white half, and if freely suspended will set at an angle greater or less according to the intensity of the radiation falling on it.

This suggests the employment of such a bar as a photometer, and I have accordingly made an instrument on this principle: its construction is shown in the diagram (Fig. 6). It consists of a flat bar of pith, A, half black and half white, suspended horizontally in a bulb by means of a long silk fibre. A reflecting mirror, B, and small magnet, C, are fastened to the pith, and a controlling magnet, D, is fastened outside so that it can slide up and down the tube, and thus increase or diminish sensitiveness. The whole is completely exhausted and then enclosed in a box lined with black velvet, with apertures for the rays of light to pass in and out. A ray of light from a lamp, F, reflected from the mirror, B, to a graduated scale, G, shows the movements of the pith bar.

The instrument fitted up for a photometric experiment is in front of me on the table. A beam from the electric light falls on the little mirror, and is thence reflected back to the screen, where it forms a spot of light, the displacement of which to the right or the left shows the movement of the pith bar. One end of the bar is blacked on each side, the other end being left plain. I have two candles, E E, each 12 inches off the pith bar, one on each side of it. When I remove the screens, H H, the candle on one side will give the pith a push in one direction, and the candle on the other side will give the pith a push in the opposite direction, and as they are the same distance off they will neutralise each other, and the spot of light will not move. I now take the two screens away; each candle is pushing the pith equally in opposite directions, and the luminous index remains at zero. When, however, I cut one candle off, the candle on the opposite side exerts its full influence, and the index flies to one end of the scale. I cut the other one off and obscure the first, and the spot of light flies to the other side. I obscure them both, and the index comes quickly to zero. I remove the screens simultaneously, and the index does not move.

I will retain one candle 12 inches off, and put two candles on the other side 17 inches off. On removing the screens you see the index does not move from zero. Now the square of 12 is 144, and the square of 17 is 289. Twice 144 is 288. The light of these candles, therefore, is as 288 to 289. They therefore balance each other as nearly as possible. Similarly I can balance a gas-light against a candle. I have a small gas-burner here, which I place 28 inches off on one side, and you see it balances the candle 12 inches off. These experiments show how conveniently and accurately this instrument can be used as a photometer. By balancing a standard candle on one side against any source of light on the other, the value of the latter in terms of a candle is readily shown; thus in the last experiment the standard candle 12 inches off is balanced by a gas-flame 28 inches off. The lights are therefore in the proportion of 12^2 to 28^2, or as 1 to 5·4. The gas-burner is therefore equal to about 5½ candles.

In practical work on photometry it is often required to ascertain the value of gas. Gas is spoken of commercially as of so many candle-power. There is a certain

"standard" candle which is supposed to be made invariable by Act of Parliament. I have worked a great deal with these standard candles, and I find them to be among the most variable things in the world. They never burn with the same luminosity from one hour to the other, and no two candles are alike. I can now, however, easily get over this difficulty. I place a "standard" candle at such a distance from the apparatus that it gives a deflection of 100 degrees on the scale. If it is poorer than the standard, I bring it nearer; if better, I put it farther off. Indeed any candle may be taken; and if it be placed at such a distance from the apparatus that it will give a uniform deflection, say of 100 divisions, the standard can be reproduced at any subsequent time; and the burning of the candle may be tested during the photometric experiments by taking the deflection it causes from time to time, and altering its distance, if needed, to keep the deflection at 100 divisions. The gas-light to be tested is placed at such a distance on the opposite side of the pith bar that it exactly balances the candle. Then, by squaring the distances, I get the exact proportion between the gas and the candle.

Before this instrument can be used as a photometer or light measurer, means must be taken to cut off from it all those rays coming from the candle or gas which are not actually luminous. A reference to the spectrum diagram (Fig. 5) will show that at each end of the colored rays, there is a large space inactive, as far as the eye is concerned, but active in respect to the production of motion—strongly so at the red end, less strong at the violet end. Before the instrument can be used to measure luminosity, these rays must be cut off. We buy gas for the light that it gives, not for the heat it evolves on burning, and it would therefore never do to measure the heat and pay for it as light.

It has been found that a clear plate of alum, whilst letting all the light through, is almost, if not quite, opaque to the heating rays below the red. A solution of alum in water is almost as effective as a crystal of alum; if, therefore, I place in front of the instrument glass cells containing an aqueous solution of alum, the dark heat rays are filtered off.

But the ultra-violet rays still pass through, and to cut these off I dissolve in the alum solution a quantity of sulphate of quinine. This body has the property of cutting off the ultra-violet rays from a point between the lines G and H. A combination of alum and sulphate of quinine, therefore, limits the action to those rays which affect the human eye, and the instrument, such as you see it before you, becomes a true photometer.

This instrument, when its sensitiveness is not deadened by the powerful control magnet I am obliged to keep near it for these experiments, is wonderfully sensible to light. In my own laboratory a candle 36 feet off produces a decided movement, and the motion of the index increases inversely with the square of the distance, thus answering the third question—"Is the amount of action in direct proportion to the amount of radiation?"

The experimental observations and the numbers which are required by the theoretical diminution of light with the square of the distance, are sufficiently close, as the following figures show:—

Candle	6 feet	off	gives a deflection of	218·0°
"	12	"	"	54·0°
"	18	"	"	24·5°
"	24	"	"	13·0°
"	10	"	"	77·0°
"	20	"	"	19·0°
"	30	"	"	8·5°

The effect of two candles side by side is practically double, and of three candles three times that of one candle.

In the instrument just described the candle acts on a pith bar, one end of which is blacked on each side. But suppose I black the bar on alternate halves and place a light near it sufficiently strong to drive the bar half round. The light will now have presented to it another black surface in the same position as the first, and the bar will be again driven in the same direction half round. This action will be again repeated, the differential action of the light on the black and white surfaces keeps the bar moving, and the result will be rotation.

Here is such a pith bar, blacked on alternate sides, and suspended in an exhausted glass bulb (Fig. 7). I project its image on the screen, and the strong light which shines on it sets it rotating with considerable velocity. Now it is slackening speed, and now it has stopped altogether. The bar is supported on a fibre of silk, which has twisted round till the rotation is stopped by the accumulated torsion. I put a water screen between the bar and the electric light to cut off some of the active rays, and the silk untwists, turning the bar in the opposite direction. I now remove the water, and the bar revolves rapidly as at first.

From suspending the pith on a silk fibre to balancing it on a point the transition is slight; the interfering action of torsion is thereby removed, and the instrument rotates continuously under the influence of radiation. Many of these little pieces of apparatus, to which I have given the name of radiometers, are on the table, revolving with more or less speed. The diagram (Fig. 8) shows their construction, which is very simple. They are formed of four arms of very fine glass, supported in the centre by a needle point, and having at the extremities thin discs of pith lampblacked on one side, the black surfaces all facing the same way. The needle stands in a glass cup, and the arms and discs are delicately balanced, so as to revolve with the slightest impetus.

Here are some rotating by the light of a candle. This one is now rather an historical instrument, being the first one in which I saw rotation. It goes very slowly in comparison with the others, but it is bad for the first instrument of the sort that was ever made.

(To be continued.)

A RULE FOR DRAWING CIRCULAR ARCS OF GREAT DIAMETERS,

INVENTED BY MR. CHEBISHEFF, ACADEMICIAN AND HONORARY MEMBER OF THE IMPERIAL TECHNICAL SCHOOL AT MOSCOW.

This rule, forming by its bending, circular arcs of diameters varying from ⅔ of a metre to infinity, replaces in itself large beam-compasses, and even allows (by continual motion) of drawing arcs of such diameters as ordinarily are received by fixing a certain number of points, namely, when the diameter amounts to some metres. Circular arcs are drawn as easily by that rule as straight lines are by an ordinary one, the whole difference being this: that for obtaining a circular arc of a given radius that rule has to be previously bent to a certain degree, determined in the following manner: the length of the radius being expressed in millimetres, you divide 10,000 by this number and find the quotient with an approximation to one tenth; then you bend the rule until you find on the scale the whole number of the quotient and on the vernier the tenth parts of that quotient.

In the case of an arc given by three points, or by some other conditions, the rule has to be bent until it receives the necessary curvature, and then the arc will be drawn as easily as a straight line passing through two points is by means of an ordinary rule.

If the radius is required, you have only to divide 10,000 by the number shown on the scale, and you find it in millimetres.

The rule consists of parts united together by small boards, the lengths and positions of which are chosen in a manner that, by changing the inclination of two contiguous parts, all the others change their mutual inclination in almost the same manner. The difference in the angles, as determined by calculation, is less than one-thirtieth of a degree. Therefore, by bending the rule the parts form a polygon nearly exact, and so the flexible plate, touching the parts of the rule, takes the curvature of an arc, which will nearly represent a circular one.

All aforesaid relates to a wooden rule of a very simple construction, which demands only careful joiner's work. A brass rule, on such a system, can be bent in a greater degree, to a radius of half a metre; and this bending is produced by means of a screw, which facilitates the finding of the desired curvature of an arc, going through three given points.

EMMANUEL AESCHLIMANN.

[The rule explained above may be seen in the very interesting exhibit of the Imperial Technical School of Moscow, Russian Section, Machinery Hall, Centennial Exhibition, of which Prof. Aeschlimann, of this institution, has charge.—EDS.]

FIRE EXTINGUISHERS.

I.

Combustion, as ordinarily known to us, is the rapid union of readily oxidizable substances with oxygen; heat and light being evolved in the act of combination. The common source of oxygen is the atmospheric air, the presence of which, then, may be set down as necessary to ordinary combustion. It is evident, therefore, that to prevent combustion we must employ materials not readily oxidizable, as iron, stone and brick; and to subdue it elsewhere we must exclude the air by the application of some incombustible substance, devoid of free or readily liberated oxygen. This substance should be cheap, plentiful, harmless to life and property, easily obtained and applied. Sand, earth, water, steam, nitrogen, ammonia, sulphurous and carbonic acid gas are used in extinguishing flame. Sand and earth are cheap and plenty; generally easy to obtain except in cold weather, but they are not readily applied, and are used only in special cases, to be mentioned hereafter.

Water is the most universally employed extinguishing agent; it is generally cheap and plenty, easy to obtain and apply; not at all dangerous to life; but its use in extinguishing a blaze in one place, frequently leads to the utter ruin of valuable and perishable property elsewhere; this damage frequently equals or even exceeds that by the fire. Moreover, in the case of burning oil and some other liquids, the application of water serves to increase the blaze, by carrying the lighter and inflammable liquid, which is soon ablaze and acting with wide-spread incendiary effect. In the great Philadelphia oil fire, the burning oil was floated by the waste water from the hose, down the streets in the gutters and between the tracks of the city railways; producing a scene of mingled beauty and terror, never to be forgotten. In such case we can find little or no safety in the use of water. Earth or sand would absorb such a flow of oil; and thus first mitigate and then extinguish the flame.

Steam is penetrating and an immediate subduer of flame in confined quarters, as on shipboard or in comparatively tight buildings. It is not, however, easily attainable, would be very destructive to life and to some kind of property, and can be applied by fixed attachments only; in which case it is one of the best extinguishers known.

Nitrogen gas is the most inert element of all the list, and is a certain, positive, penetrating and effectual extinguisher of flame. It is harmless to property, although it will not support life, and hence would be dangerous to sleepers in an apartment where it was used in excessive quantity. But it is not easily and quickly generated, hence impractical to use it without huge reservoirs connecting with a fixed system of pipes. Being almost as heavy as air, it readily covers a burning oil, smothering the flame at once.

Ammonia subdues flame at once; and may be quickly generated in portable apparatus, and applied either pure or mixed with water. But it is caustic and corrosive, and destructive to many kinds of property and to all forms of animal life. Moreover, being lighter than air, it is difficult of direction, and of application to burning liquid surfaces, or to any other fires requiring to be attacked from above downward.

Sulphurous acid gas is a very poor supporter of combustion; is heavier than air; very irritant and suffocating; bleaches and injures many species of merchandise. It is produced by the burning of sulphur or the roasting of metallic sulphides, and hence could hardly be made available for extinguishing fires, unless liquefied under pressure or stored in huge gasometers.

Carbonic acid gas is very readily, rapidly, and cheaply generated from compact materials, and applied either alone or in connection with water. Its weight being greater than that of common air, it descends therein, and a stream of it, although invisible, may be directed with like precision. Like nitrogen, it is an admirable extinguisher of oil-fires. Although creating asphyxia, it is in no other way injurious to animal life; and there are few kinds of property which it could damage. Hence its general and rapidly increasing use to subdue the most stubborn or the most appalling flames, when the situation permits. As a matter of course, so light a substance would be of little use in subduing a fire at any distance from the directing nozzle of the conducting pipe. When used in connection with water, its carrying power and directibility are increased more than sufficiently to counterbalance its decreased extinguishing capacity. Its principal use has been in portable apparatus designed to extinguish incipient fires.

An "an ounce of prevention is worth a pound of cure," and "a stitch in time saves nine," so the motto of Chief Sexton, of St. Louis, that "the first five minutes at a fire are worth the last five hours," here applies admirably. The Bard of Avon reflects the popular sentiment of his time in the lines

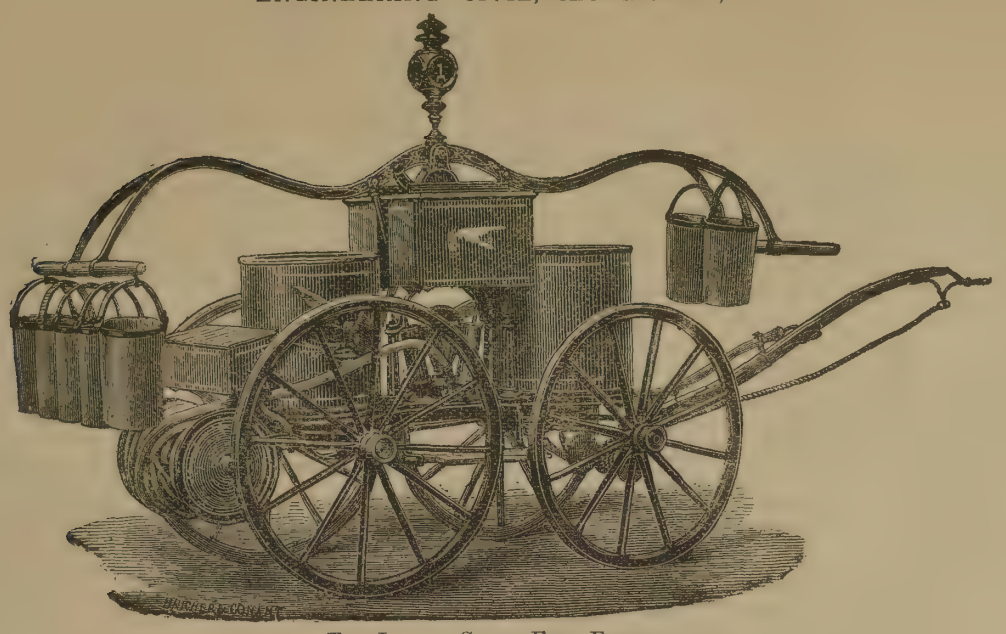
> "A little fire is quickly trodden out
> Which, being suffered, rivers cannot quench."—*Henry VI*, iv, 8.

The spark, the glow, or the flickering blaze that *may* initiate a conflagration, succumbs to the quickly applied gallon or so of water, charged with carbonic acid gas. Had Mrs O'Leary's stable been protected with one of the many "extinguishers" now so extensively made and sold, Mrs· O'Leary's cow would not, like "th' aspiring youth that fired th' Ephesian dome," have become immortal; but Chicago and the whole country would have been spared a fiery ordeal, and the consequent prostration from the great fire of 1871. The wide and successful use of "extinguishers" designed to subdue incipient fires, warrants us in devoting spare space to the description and consideration of the many varieties offered to the public.

G.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.



THE LITTLE GIANT FIRE ENGINE.

The Little Giant Fire Engine, of A. F. Spawn & Co., New York (see figure), has two copper open-top cylinders, placed fore and aft, and one containing an alkaline carbonate solution, the other an acid solution, both renewed by powder from top bunkers. Between the cylinders are two single-acting nearly vertical plunger-pumps, worked by a fore and aft brake-lever. One of these pumps draws and forces the acid, the other the carbonated solution. The two meet, evolving carbonic acid gas, which greatly increases the extinguishing power of the stream. But a small stream is required; this may be projected to a considerable distance. When desired, pure water may be forced.

Hinc illæ lacrymæ!—Until quite recently, Philadelphia could boast of at least two institutions, the possession of which fairly entitled her to be looked upon as favored amongst the cities of the earth. Of these, the first was the Keely Motor; the second, the Centennial Exhibition. But *tempora mutantur*, and it has remained for invidious Baltimore to seriously imperil this exclusive distinction, by producing a genius of the name of Kelley (suggestive similarity!) of whose ability to knock his famous predecessor even higher than the traditional kite an intelligent correspondent of the local press leaves us no room to doubt. Crushing as the blow is to our local pride, our duty as journalists to chronicle with strict impartiality the progress of science as applied to the useful arts, compels us to substantially record what "an eye witness of his motor and a convert to his theory," is moved by enthusiastic conviction to say concerning Archimedes Kelley, viz:—

"From Baltimore was sent forth to Washington, some thirty years ago, the first telegraphic dispatch, and here, too, at one of her machine shops we now find, in course of construction and nearly completed, a motive power that will surely revolutionize in its department of the world's affairs as completely as did Morse's great invention quicken the then dull impulses of all the enlightened people of every land. Inquiry enabled us to learn that this new motive power, soon to be pronounced matchless and incalculably valuable, is the brain fruit of a citizen of Washington, Mr. Joseph F. Kelley, well-known to many in this city of his home.

"This motive power is a very simple affair, and cheap in cost of construction. Its value will be appreciated, and the money bags of millionaires be opened to its inventor when, with *half a horse power*, it shall propel a loaded street-car quickly, noiselessly and safely; or when, with an expenditure of not more than fifty dollars worth of crude petroleum, it will speed a large ship across the Atlantic at a rate outrivaling the time so boasted by the fleet and huge iron steamers now engaged between New York and Liverpool. However, all must see for themselves. We have seen and are thoroughly convinced, and therefore its achievements will not amaze us as they will others. The question may be asked, what is this machine? It is but the practical application and illustration of the Archimedean idea—"A lever long enough and a fulcrum whereon to rest it, and I will move the world." The inventor utilizes the fulcrum and lever in conjunction as a power, as is plainly to be seen, and no person can conjecture that there will be any limit to its capacity, usefulness in various ways, or immense value."

Another illustration that the most brilliant discoveries, are at once the simplest. For how many generations has the fulcrum and the lever been known, and yet it remained for the genius of a Kelley to teach us to use them in conjunction. But let us not anticipate!

"To see the simple machine, with its two fulcrums and two levers, two inclined planes and two heavy weights, (about all there is of the vitally important features,) moving as a thing of life and exerting, without apparent effort, the powers of armies of giants, is a sight all must see to appreciate."

The "two heavy weights," we take it, is a playful allusion to two of aforesaid millionaires, who have had the good fortune to be let in on the ground floor.

Our amiable friends, the Riehlé Bros., will probably say of the fling contained in the next statement, that it must be felt to be appreciated—for the writer, with no consideration for their feelings, adds that, "it is a rough piece of mechanism, as are all testing apparatuses."

Then, modestly forgetful of the conviction which his lucidity must have carried to the minds of his readers, he concludes with, "Truly, we are but on the margin of an era of astounding discoveries and developments."

"Modestly forgetful," we said; "else, why 'but on the margin?' Why leave us on this ragged edge?"

Exhibition of Objects of Health and Public Safety at Brussels.—The London *Pall Mall Gazette* affords us the following information concerning the interesting exhibition in progress in the above-named city:—

"Close to the park entrance of the English section the largest gallery of the Exhibition branches off. The first two-fifths of it are occupied by Germany. The German exhibits are very methodically arranged, and comprise an enormous variety of things relating to public health and the preservation and saving of life. Next comes Belgium, occupying about as much space as Germany, and illustrating by her productions the enormous industrial progress of the country. Russia occupies about a fifth of the hall. From the Belgian compartment the French section branches off to the right. It is less varied than that of the other great nations, and contains notably few objects relating to the ambulance service. The special exhibition of the city of Paris, which is placed at the end of the gallery, is very remarkable. From the other side of the Belgian compartment a lateral gallery, containing heavy and voluminous objects, leads to the long gallery, of which one side is devoted to Austria, Hungary, Italy, Switzerland, the Netherlands and to additional exhibits of Belgium and Switzerland; and the other side to the various railway exhibits, showing the latest inventions for making railway traveling safe and comfortable in time of peace, and the adaptation of railway carriages to the ambulance service and the transport of the wounded in time of war. Among the Italian exhibits is a model of the cremation apparatus from the cemetery of Milan. A side gallery opening on the French section contains the exhibits of Denmark and Sweden and Norway, and the remarkable exhibition relating to the construction and furnishing of schools organized by the Belgian Government. A number of very heavy machines, boilers and diverse objects are placed in the ground pertaining to the Exhibition. Close to the principal entrance in the park is a Russian railway carriage of a novel kind and construction, representing in natural size a vertical section of the great works of the Senne, executed at Brussels.

Canadian Intercolonial Railroad.—An event of importance in the progress of the northern portion of the American continent took place on the Fourth of July in the opening of the Inter-Colonial Railroad in the Dominion of Canada. This road, which is 687 miles in length, was built in part by the Dominion government, portions of it having been constructed by the local governments of provinces previous to confederation. One division of the road begins at Moncton, New Brunswick, and ends at Riviere du Loup, in the Province of Quebec, with branches running in various directions to important points. A branch also extends from St. John, New Brunswick, to Point du Chien and other localities in that direction, the whole being connected in such a manner as to make the improvement continuous and bind closer together the people of the East and West. Under the terms of confederation all these roads become the property of the Dominion of Canada, and the government has invested in their construction twenty millions of dollars. Along the line at many points the local trade is already heavy, and will rapidly increase. Lumber is the leading article, but there are a score or more of products which, when they can be carried rapidly and cheaply to market, will be crowded into the cars and augment the profits of the road. It is expected that the passenger lists of the ocean steamers stopping at Halifax will be increased by this new means of reaching that port from points in Middle and Western Canada. On the whole, the movement is highly interesting and shows renewed energy and business progress in a quarter where such manifestations are badly needed.

Captain Eads and His Work.—The report of recent soundings at South Pass deserves notice. According to that report, the average depth of the channel between the jetties is considerably over 20 feet, the greatest depth being 25½, and the least 19. Altogether there were twenty-eight soundings taken.

Of these only three were as small as 19 feet, three of 19½, four of 20½, six of 21, four of 22, three of 23, three of 24, and the rest running 24½, 25, 25¼, and 25½ feet. Truly a gratifying result, and one fraught with the brightest promise for the commercial future of New Orleans.

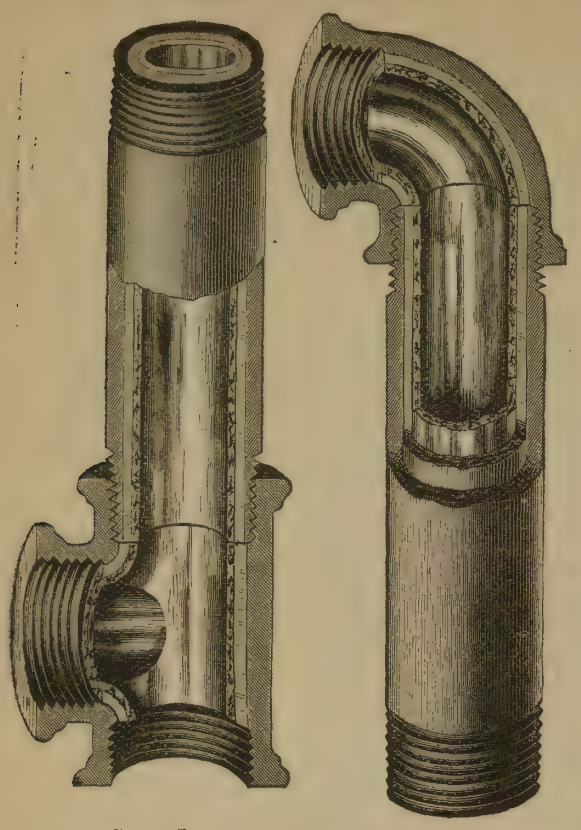
Perhaps the enemies of the jetty project will now admit that they were not as wise and far-seeing as, two years ago, they would have had us believe. Every single one of the lugubrious predictions they then insisted on, have been falsified by facts. The jetties have not been blown away by storms, or displaced by mud lumps; they have not caused an overflow; they have not blocked the port in the interest of the St. Louis bridge (some lunatic made that charge); they have done nothing their opponents prophesied and everything their opponents denied. In short, after a very few months, Captain Eads' jetties have converted a neglected outlet, boasting scarcely seven feet of water in its most liberal movements, into a broad, deep channel capable of floating the largest ships in our trade, and possessing every element of improvement and permanency for the future.

Something remains still to be done. There is some shallow water inside the river end of the jetties, and this must be deepened ere the channel which Captain Ead's pluck and science has given us can be utilized to its full extent. The suggestion has been made that the Government dredges at Southwest Pass should be used for this purpose, seeing that the jetty channel is in all respects a better and more practicable one than any that ever has been or ever can be produced by the means at the disposal of the engineer department. But, some weeks ago, when this suggestion was first made, objections followed to the effect that the success of the jetties had not been demonstrated, and that by removing the dredges from Southwest Pass the Government would be sacrificing a secure channel in favor of a mere experiment. Since then Captain Eads has worked on quietly and confidently, and in the interval many vessels have grounded in Southwest Pass, while many vessels of equal draught have passed safely and expeditiously between the jetties. Nothing now remains save to remove a narrow and comparatively insignificant bar lying above the head of the works. When that shall have been accomplished, the long-desired consumption will be attained, and New Orleans will rejoice in a permanent deep water channel to the sea. The jetties are steadily and rapidly deepening the water within their influence, and no reasonable doubt can be entertained as to their complete and triumphant success.—*New Orleans Bulletin.*

American Engines in Holland.—It affords us pleasure to note that the Fitchburg Steam Engine Co. is delivering pumping engines in Amsterdam.

Polygonal Column Rolling Machine.—Mr. J. Hahn of Pittsburg, adds to the ordinary pipe rolls a series of rolls which give the welded tube a polygonal section.

CENTENNIAL NOTES.



GLASS-LINED IRON WATER PIPES.

There is a story afloat, and having in it some measure of truth, to the effect that a plumber, on being asked to give an estimate for re-piping a certain house and keeping his work in repair for three years, offered to do it for a given sum and take the house in part payment.

It is certain that the first cost of "plumbing" a house with lead or iron pipe is heavy, and the repairs cost sums which are absolutely shameful. Further, lead pipes are slowly dissolved by certain soft waters, and distressing cases of lead-poisoning from this source are constantly reported, while others no less certainly happen but fail to be reported or understood.

Rats gnaw lead pipe and cause leaks, giving rise to further damage.

Frost bursts lead or common iron pipe.

So-called "galvanized" iron pipe lose their zinc coating in time, and become corroded.

Tin lined lead pipes burst with frost; are gnawed by rats; and one can hardly imagine how galvanic action and lead solution can be prevented at the ends where the pipes are soldered together.

Tin lined iron pipes burst with frost and become corroded at the joints.

Rubber-coated iron pipes burst with frost and impart a somewhat sulphurous taste to water.

The pipe illustrated in the cuts herewith are of iron, lined with glass; between the iron and the glass lining is a space filled with plaster-of-Paris, a non-conductor of heat.

Rats cannot gnaw these pipes, nor water flowing through them affect their glass lining; the plaster is claimed to protect them from frost. The abutting joints are luted with a small quantity of hydraulic cement in the small seam between the ends of the minor glass tubes.

Prof. Agassiz found the inhabitants of his salt water vivarium poisoned by supply pipes of lead, rubber, and gutta-percha. These glass-lined pipes would be eminently adapted for aquaria. The smooth glass lining gives a minimum of friction, and hence reduces but little the flow through long lines.

This pipe is made by the Glass Lined Pipe and Tube Co., 548 Pearl Street, N. Y.; and is exhibited in Machinery Hall, Column B–20. It is now placed upon the market with excellent recommendations based upon four years' quiet, although extended, tests.

The Doremus Automatic Sofa Spring-Bed and Lounge can, by a single movement, be converted into a bed, lounge or sofa. It can be seen on exhibition at column T, 48, Main Exhibition Building. C. K. H.

The Buffalo Scale Company has on exhibition several of its Patent Combination Beam Scales. This combination beam is very convenient. The scale used for weighing grain is so arranged that but a moment's time is necessary to ascertain the exact amount, by bushels or pounds, of either wheat, corn or oats. This convenience is given by having four beams combined in one—one beam marked for oats, one for corn, and one for wheat, with the fourth beam marked in pounds to get the fractional parts of a bushel. By the use of the combination beam, all danger of mistakes by computing figures is avoided. C. K. H.

KEYSTONE BRIDGE COMPANY'S EXHIBIT.

Location—T 66, No. 4512, South side of Main Building, second door from east end.

I.

"*Model of Raritan Bay Swing-Bridge.*—The model is constructed on a scale one-twenty-fourth of the full size of the bridge, and represents a span of 472 feet in total length. This span is the longest pivot span ever constructed In the United States, and it is believed to be the longest in the world.

The trusses are 40 feet high at the centre and 30 feet at extremities. The upper chords, consisting of channel bars and plates, are made continuous, being proportioned to resist the tensile stress due to the dead weight of the bridge when open, as well as the maximum tensile and compressive stress when the bridge is closed and loaded with the maximum live load of 2,500 pounds per lineal foot, with a panel load of 4,500 pounds per lineal foot.

The lower chords are parted at the centre, so that the ends of the trusses may be adjusted by wedges to any desired elevation. The posts are hollow, and admit of being painted on the interior surface. The central drum is sufficiently strong to support the bridge and load upon the central anti-friction cone bearing, or on the wheels. By means of the centre suspension bolts, the weight of the structure can be placed either partly or entirely on the central cones, or on the bearing wheels.

There are 30 bearing wheels, two feet diameter, twelve inches face, which traverse between steel-faced tracks. Before the bridge is swung open, the entire structure is lifted about four inches by means of four hydraulic rams placed in the transverse girders of the drum, under the four central posts, the pumps being operated by the double-cylinder engine, with cylinders eight inches diameter and ten inches stroke, employed also to turn the bridge. The turning gear is brought into action by means of a friction clutch, and the two pinions are made to act equally on opposite parts of the rack by means of an equalizing attachment in the large mitre wheel, placed between the shafts that drive the pinions.

When the bridge is rotated into the line of track, it is locked by automatic locks at both ends, and then, by turning a valve, lowered on solid bearings on the drum and at the extremities, the projecting rails bearing in the same shoes that receive the rails of the permanent spans. About one-half of the dead weight of the structure is made to bear firmly on the solid adjustable supports on the rest piers. By this disposition of the load, the bridge is rendered firm and solid under the weight of passing trains, and the trusses act as two independent spans. The weight of the entire structure above the drum is six hundred tons. This immense weight is operated with ease by the engine, turning gear, and hydraulic machinery. When one arm is loaded, the other arm does not rise and vibrate on the remote bearing, as is the case with swing-bridges designed as continuous girders over three supports. This objectionable feature in continuous girder swing-bridges can be obviated only by lifting both ends by suitable apparatus, or by holding down one arm when the other is loaded. In either case strains are caused in the trusses, for which special provision must be made in the proportions.

To obviate these difficulties the bridge was designed both as a cantilever and as two independent spans, with the arrangement described to place one-half of the weight of the bridge on end supports. The hydraulic rams were placed under the centre in order to render the arrangement of pipes more compact, and to utilize some large rams remaining on our hands from the erecting works of the St. Louis bridge; otherwise rams of one-half the capacity might have been used under the extremities of the trusses. This latter arrangement, however, involves the use of wedges to sustain the weight of trains, and, in other respects, is less satisfactory. In this form of pivot bridge a slotted link connection can be used at centre of upper chords to destroy the continuity of the chords, when the bridge acts as two independent spans. The bridge was designed by J. H. Linville, C. E., and constructed by the Keystone Bridge Company for the New York and Long Branch R. R. Co."

(*To be continued.*)

Ralph's Packing Machine, for packing powdered materials in pasteboard boxes, tin cans, or bottles, of any size, has an Archimedean screw turning in a horizontal filling horn projecting from the bottom of a vertical hopper. The powder is conveyed into the receptacle by the revolution of the screw; when the exact bulk required has been crowded into the receptacle, an adjustable weighted lever is tripped by the outward moving receptacle, and thus a friction clutch on the screw-shaft is thrown out, and the motion stopped. There are two filling screws on the machine shown.

Brown & Sharpe Manufacturing Co., Providence, R. I., show a fine universal milling machine, and a number of instruments of precision, well worthy of detailed description, which we hope shortly to give.

The Pantograph Engraving Machines exhibited by Hope & Co., of Providence, Rhode Island, are located between the Waltham Watch Co.'s department and the Corliss Steam Engine.

The process of engraving copper rollers for calico printing by means of this machine is as follows:—A correct copy is taken of the pattern to be engraved; and by means of a camera is enlarged to any required size; this enlarged copy is then laid on a table forming a part of the machine; and over the lines of this copy the operator guides a stylus or tracing point, which, by being connected with suitable mechanism, causes a number of gravers or diamond points to come in contact with the roller, each point duplicating on its surface the exact copy of the original design. The gravers do not cut the copper, for the roller is covered with a coating of varnish; and upon this coating the figures are traced. After this, the roller is immersed in nitric acid, where it remains till the metal has been eaten away to the required depth, the varnish preserving the surface from any action of the acid excepting the precise lines required.

Some very important recent improvements are embodied in these machines, enabling the operator to obtain a variety of effects from the same design. They are also readily arranged for engraving geometrical and ornamental figures, and are well adapted for bank-note engraving.

This system of engraving has been of much value to the printers of cotton and other fabrics, enabling them to engrave a larger number of patterns and at a considerable reduction in price.

Messrs. John Roach & Sons (New York City, and Chester, Pa.) show a number of models of vessels, etc. There is a complete working model of the engines of the Sound steamers "Bristol" and "Providence. The Bristol has the largest steam cylinder yet cast; it being 110″ diameter, 14 ft. stroke, and the largest and heaviest truss beam yet made for a steamer, it being 24 tons in weight. The paddle-wheels are 42 ft. in diameter.

There is a model of the double-turreted monitor "The New Puritan," now re-building at the Chester works, and which has 2000 tons of side armor, 12″ thick. The turrets are 15″ thick, and each weighs 375 tons, exclusive of guns. The vessel is of the cellular construction; 5500 tons measurement, 7500 tons displacement; she will have two 20″ smooth-bore guns and two 12″ rifles.

Among the models may be especially mentioned that of the Geo. W. Elder, an iron screw vessel, stated to have run for a year on an average coal consumption of 1·86 lbs. per P. H. per hour. The "Colon" is said to have run still more economically on a round trip between New York and Aspinwall.

A portion of the "Puritan's" side armor is shown, being a 12¾-inch plate of fagoted iron 10 ft. by 3 ft. 8 in., weighing 10 tons. It is planed to show its quality, which is quite good. The establishment can produce fagoted plates of the same superficies up to 3 ft. thick. This plate is to be tested by 20″ solid shot. The ram under which it is built up weighs 7½ tons.

There is a superheater head made from a circular plate of ⅝-inch charcoal iron, 106 inch diameter, flanged down all around 5 inches; in it are four 30″ flue openings, flanged 6″ deep, and worked for 7″ holes without thinning. The flanger, Mr. Ambler, divided the plate on a diameter and re-welded it without distortion or thinning. This is stated to be the largest single plate circular head ever made in this country.

There is a finished wrought iron 5-ton crank-shaft for the side-wheel steamer Massachusetts. There is another fine crank shaft for the same vessel, 36 ft. long, 22″ diameter, and weighing 26 tons. The vessel has a steam cylinder 90″ by 14 ft.

Morris, Tasker and Co. (Philadelphia and New Castle) have in Machinery Hall an iron pavilion, 30 ft. high, of gas pipe. The dome-shaped roof is made of a coil of 1½ inch pipe, 582 ft. long, and is surmounted by a gilt eagle; under it there are three shelves made of brass cocks, valves, etc. The four supports of the pavilion are pipes of 4, 5, 6 and 7 inches diameter. At one corner there is a stack of stop-valves ranging from 12 inches to 1 inch.

Frick & Co., Waynesboro', Pa., show a portable engine with several good features, among which may be mentioned a "ball and socket," in place of the ordinary fifth wheel.

The New York Safety Steam Power Co. show six sizes of vertical engines, of fine outlines and good workmanship, although in some respects the valve gear is faulty. There is a horizontal engine with slide-valve below the cylinder; and a steam jacket 51 ft. long, 8 ft. beam, with vertical engine 8″ by 8″.

The Krupp 14-inch Gun is 25 ft. long; greatest diameter 5 ft. It has 80 rifle-grooves, having ⅜ of a revolution in their whole length. The weight of the gun is 58,640 kilog. (about 64 tons). Its charge of powder is 500 lbs., throwing a 1200 lb. shot, and penetrating a 12″ plate at two miles' distance.

MISCELLANEOUS.

Vivisection.—The forthcoming number of Dr. Crookes' Quarterly Journal of Science, of which we have been favored with advance sheets, through the courtesy of the editor, contains a most admirable and temperate review of the question of vivisection, which, as our readers may not be aware, has, at the instance of certain zealous humanitarians (!) been made the subject of an inquiry by a Royal Commission. We are unable to reproduce the article in full, much to our regret, but must content ourselves with a brief review. The author, first commenting upon the inconsistencies of modern humanitarianism, makes the point against it, that "it fastens upon matters never demonstrated to be evils minute in their amount and unobtrusive in their character, whilst practices much more questionable in their nature, and almost world-wide in their extent, are allowed to pass unchallenged." "Perhaps, however," adds the author, "there is method in this seeming madness. Sport and fashion are popular and powerful, and may therefore—to quote a somewhat cynical proverb—'steal a horse' with impunity, whilst science, weak and uninfluential, 'is hanged for looking over the gate.' This may perhaps explain the recent raid made upon vivisection."

Then follows an examination of the cases in which man claims the right to inflict pain upon the lower animals. Of these there seem to be five classes, namely :—

1. In self-defence.
2. In order to obtain articles of real or supposed necessity.
3. In compelling animals to obey his will.
4. In the pursuit of amusement.
5. In the pursuit of knowledge.

The author briefly, but pointedly, shows that in the first four of these classes a prodigious amount of suffering and death is inflicted upon the lower animals, much of which is inflicted heedlessly and needlessly—to gratify a momentary passion—an ungovernable temper, the senseless and often barbarous whims of fashion in articles for adorning the person or for that which even the public opinion of an "ostentationsly virtuous people" is pleased to designate as "sport."

"We now come," says the author, "to the last case. A small amount of life is sacrificed and a small amount of pain is inflicted in the pursuit of knowledge. Singularly enough this occasions a greater outcry than any of the former cases. We come, then, to the singular conclusion that it is permissible to kill animals, and to inflict pain upon them, for our safety, for emolument, convenience, luxury, ostentation, or amusement, but not for the acquisition of knowledge! Surely such a proposition, if once fairly stated, carries with it its own refutation. But the knowledge sought for and acquired by means of vivisection is not for the mere gratification of our curiosity ; it has already thrown most valuable light on the preservation of health, the prevention of disease, and the consequent prolongation of life. Hence it may be said that the animals submitted to vivisection are indirectly, indeed, but not the less decidedly, sacrificed to our safety. If we may not destroy life for our safety, what right have we to take it for any purpose less urgent? Therefore we maintain that no person who kills animals, or causes them to be killed or subjected to pain for any purpose whatever, or derives any benefit from such death or infliction of pain, is logically justified in denouncing biological experiments. But some opponents may urge that what they object to is not the mere death of a few animals, but the excessive and prolonged torture to which they are previously exposed. We reply that if it is once conceded that we may under certain circumstances inflict pain upon animals, provided that we have a worthy and important end in view, the precise amount of pain is no longer a question of principle. Surely for an end so important we may take means which would be unjustifiable if our purpose were merely to compel a refractory beast to obey our will or to minister to a frivolous passion for ostentation and display. The pain inflicted in vivisection is much smaller in the number of cases, and certainly not more intense or prolonged in any one case, than that to which animals are subjected for other and less important ends. We may be told that one wrong does not justify another ; but may we not bid the agitators take the beam out of their own eye before they seek to remove the mote from ours? When anglers and coursers, *battue*-sportsmen, Hurlingham-heroes, and wearers of seal-skin jackets presume to denounce vivisection, their only right is that of impudence.

"It must be remembered that biologists, far from inflicting pain needlessly and wantonly, or from taking any pleasure in its infliction, seek, by every device conceivable, to minimise the sufferings of the animals operated upon. The smaller the shock given to the subject, and the less its normal condition is affected in anything beyond the exact point at issue, the more trustworthy will be the result. The biologist, therefore, who should inflict any needless or avoidable torment on the animals experimented upon, would simply defeat his own object. It is important here to remember that, according to the Report of the 'Royal Commission on Vivisection.' the Secretary of the Society for the Prevention of Cruelty to Animals frankly acknowledges that he does not know a single case of wanton cruelty. Surely if such an admission is made by the responsible official of a powerful and influential organization, with abundant means at command for probing the matter to the very bottom, and spurred on to action by a sensational outcry, we shall be warranted in assuming that no such cases exist."

The author then effectually disposes of the argument, that the practice of vivisection must have a brutalizing effect, and tend to render the medical practitioner inhuman—by reminding the opponents of vivisection that such deplorable consequences cannot rationally be predicated of an act conceived and executed in the highest interests of humanity ; and by showing, from the example of the Hindus and Turks, that great respect for animal life not only does not necessarily involve reverence for the superior sanctity of human life, but that it may co-exist with the utmost inhumanity to man. The Turks, for example, are famed for their tender consideration towards animals, yet to man they are merciless.

The author's reply to the objection of the agitators, that "vivisection is not a trustworthy method of interrogating nature," is simply unanswerable. Proceeding from the suggestion, that *a priori*, the distinguished physiologists of the past and the present who have from time to time undertaken experiments upon living creatures would be able to judge whether the method was safe or fallacious, he pertinently asks, "Do they really require to be instructed on this head by unscientific outsiders?" then proceeds to demonstrate the homeopathic amount of consideration to which even the most admirable people are entitled to receive at the judgment seat of a wholesome public opinion when they presume to speak upon subjects of which they are utterly ignorant, and on which they have not even sought for correct information, by advancing the following points in the history of the subject.

"The discoveries of the action of the lacteal and lymphatic system, and of the compound function of the spinal nerves may serve as illustrations. These discoveries, it has been justly said, lie at the very foundation of our present knowledge of the laws of animal life. Yet these discoveries are mainly due to vivisection. Turning from abstract biology to practical medicine, what would be our treatment of the diseases of the heart and blood-vessels, if we suppose Harvey's great discovery blotted out? Hunter's treatment of aneurism —a disease previously always fatal—springs from the same root, and was discovered and verified in the same manner. Look at the operation of ovariotomy, by which one single surgeon has saved the lives of more than five hundred women. This process, or at least a certain point which it involves, was first proved upon dogs, rabbits, and guinea-pigs. Without such preliminary experimentation no medical man would have ventured on a procedure formerly held necessarily fatal. To declare, then, that vivisection, as a means of research, is barren and deceptive, betrays an amount of ignorance which is positively indecent. It is the bounden duty of all who undertake to enlighten the public on any subject to make themselves first accurately and fully acquainted with all its bearings. Otherwise, instead of enlightening, they deceive and lay themselves open to the natural suspicion that such is their intention. He who comes forward in a court of justice to give evidence on matters which he does not know, is considered a perjurer. Is not the position of the humanitarian zealot who scatters baseless assertions broadcast morally, though not legally, exactly similar? Surely the few illustrations which we have cited, capable as they are of being indefinitely multiplied, form an overwhelming proof of the value of vivisection, and must utterly silence all the cavils raised against it on the score of inutility. Nay, they ought, in our opinion, at least to be held decisive of the whole question. What, in opposition to such solid facts, are the hysterical utterances of Mænads who proclaim that their "hearts," and possibly other vital organs, are sick? Let no one say that we are advising to do evil that good may come ; that which yields such essential services to the whole human race cannot be declared evil by any one, except he denies to man any rights over the brute creation whatsoever. The Royal Commissioners point out that most important researches, involving experimentation upon animal life, are now in progress. These relate to some of the "severest scourges which would afflict the human race," such as cholera, consumption, blood-poisoning, typhoid, the bites of poisonous serpents. Are such investigations to be suspended? Were we prone to sensationalism, we might paint the shades of the thousands of our fellow subjects who yearly perish in India from the bite of the thanatophidia hovering over the couch of the anti-vivisectionist fanatic, and shrieking in his ear that they might have been saved had he not begrudged the death of a few rabits and guinea-pigs. No one can abhor more than do we the infliction of any wanton torment upon animals. We even object to all avoidable destruction of vegetable life. But if the remedy for the bite of the cobra alone could be found, we should consider it cheap if all the guinea-pigs in creation had been used up over the discovery.

"There are those who declare that, rather than owe their life or that of their children, to methods elaborated in such a manner, they are willing to die. It may be so, and we do not dispute their right to decide thus for themselves ; but we entirely deny their right to speak for others. When they attempt this, when they seek to suppress vivisection, they fight —as humanitarians are very apt to do—not for liberty, but for supremacy. They seek to deprive others, who are not willing to die so long as a remedy can be found, of a source of benefit and safety.

"But the boast of rejecting improved medical treatment founded upon the results of vivisection is idle and empty. They cannot, if they were to make the attempt. It is scarcely too much to say that whenever they consult a medical practitioner they enjoy, more or less, and directly or indirectly, the benefits of discoveries made in this denounced manner. Can they efface from the mind of their physician or surgeon his knowledge of the circulation of the blood and all its consequences? Can they call up from their graves the ante- and anti-Harveians to treat their diseases? Surely, then, they are in a false position. They quench their thirst at a stream, and yet would seal up its springs!" W.

Steel Nails.—Messrs. Reese, Graff & Woods, Pittsburg, are making steel nails of fine finish. It is claimed that on account of the less weight and size required to obtain a given strength, they can be furnished as cheaply as iron nails.

Items.—Major Ross affirms that the blue color sometimes produced in the incineration of bread, is an artificial ultramarine.—Carnelly proposes a colorimetric test for estimating small quantities of copper, based upon the comparison of the purple-brown coloration with potassium ferro-cyanide afforded by the given solution, with a similarly colored standard copper solution.—To detect the presence of arsenic, Davy places some of the suspected solution in a test tube with a little water. A particle of sodium-amalgam the size of a wheat grain is added and the mouth of the glass is at once covered with filter-paper moistened with nitrate of silver. If As is present, the paper will receive a dull black or deep brown stain. Davy affirms that 1,000,000th part of a grain of As dissolved in 1 c. c. of water, can be detected in this manner. —From certain spectroscopic observations, Lockyer infers that the so-called chemical elements are not simple bodies.—Dr. Vogel recommends paper soaked in glycerin as suitable for hermetical coloring, because the glycerin always remains damp, and stops up the pores of the dry penetrable paper, so that no air can get through.

Mineralogical.—A new crystalline organic mineral has been described by M.D. Loiseau, under the name of raffinose. Its chemical constitution is given as carbon 36·30 per cent. ; hydrogen, 7·07; oxygen, 56·63 ; corresponding to the formula $C_8 H_7 O_7$; or to one of its multiples. [*Quart. Jour. of Science*, vi, 430.]

THE POLYTECHNIC REVIEW has its temporary Centennial headquarters at the exhibits of Cornell University, B—68, Machinery Hall, and of the Estey Organ, P—63, Main Building.

BIBLIOGRAPHICAL NOTICE.

A NEW TREATISE ON STEAM ENGINEERING, PHYSICAL PROPERTIES OF PERMANENT GASES, AND OF DIFFERENT KINDS OF VAPOR. By John W. Nystrom, C. E. Philadelphia, J. B. Lippincott & Co., 1876. 185 pp. 8vo.

Mr. Nystrom has here given us his best work, and one which is well worthy of perusal and constant reference. He has given simple workshop terms to supplant the confusing and ambiguous expressions which have so long mystified and befogged both the readers and the writers of works on dynamics. He has recalculated many tables and formulæ found to be unreliable (Fairbairn's for instance), and has added others of use to engineers. Some new characters for grate surface, heating surface, etc., have been made and are used to advantage in the formulæ, some of which we shall reproduce in our pages as examples of clear and practical rules for obtaining definite results.

INDUSTRIAL.

E. P. BAUGH'S SECTIONAL MILLS FOR ALL HARD SUBSTANCES.

These mills are now used upon a great variety of work throughout the United States, but the daily applications from new industrial sources for information respecting them, renders necessary a more complete description than any hitherto given.

The requirements of a large fertilizing establishment in crushing and grinding raw bones and phosphatic guanos, originally developed the efficiency of these Mills. Great strength, durability of wearing parts, and economy of their renewal, are the first requisites of such a work. Several years of practical operation so fully matured and perfected these requirements, that the Sectional Mill became almost indispensable to manufacturers of fertilizers. and with little

Fig. 1

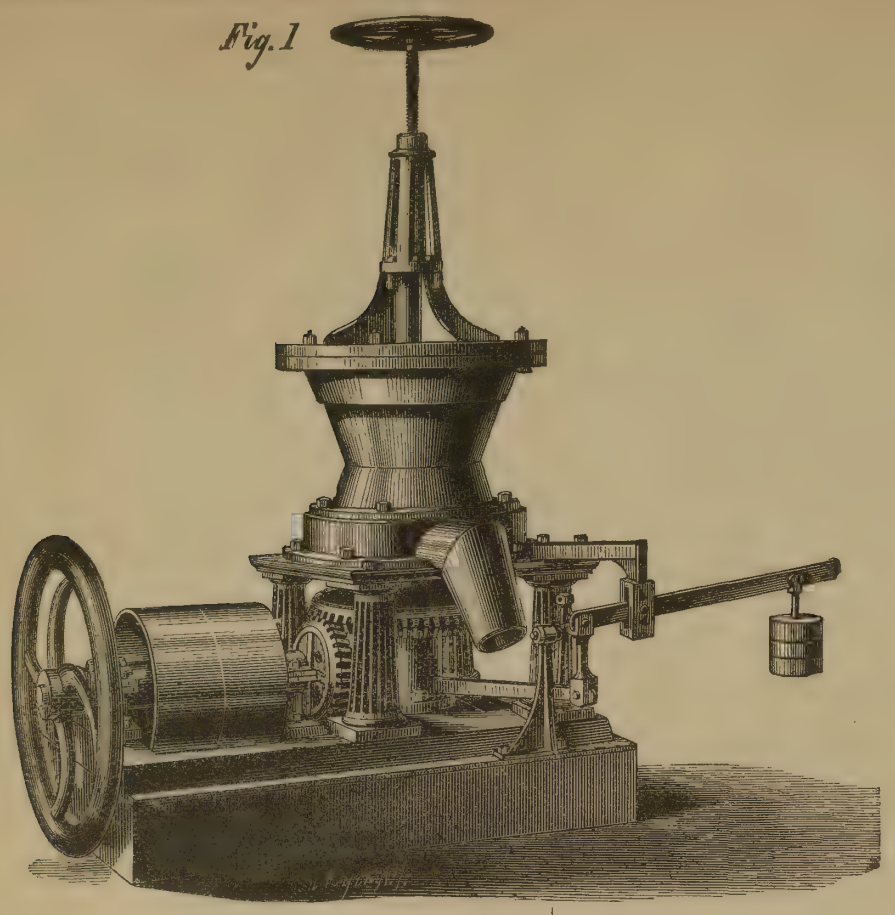
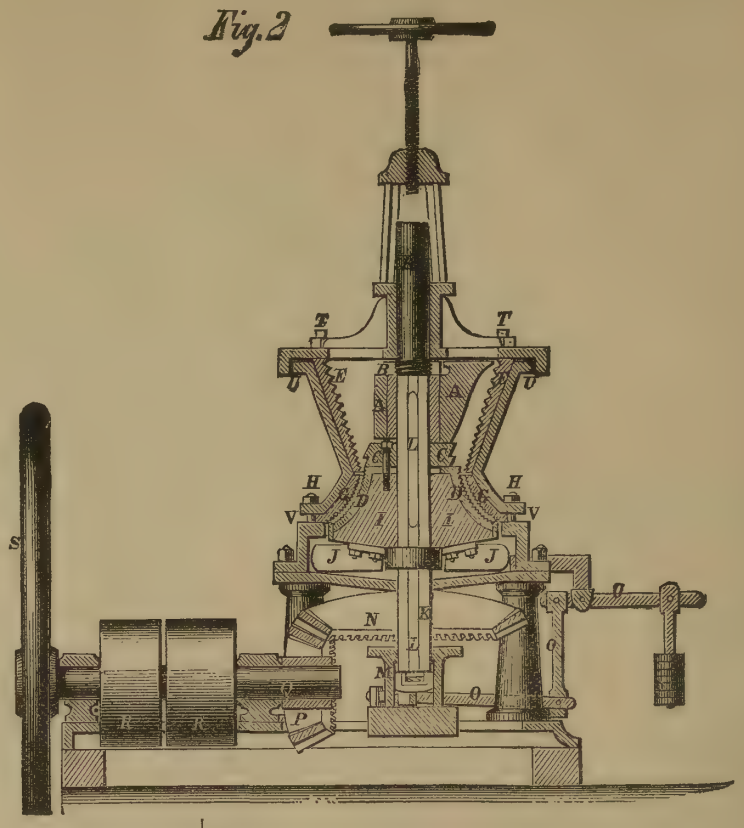


Fig. 2



effort on the part of the builders they came rapidly into very general use for this purpose. As their efficiency became more widely known, a great variety of uses devolved upon these Mills, until there is at this time scarcely a material upon which grinding mills are employed but these Sectional Mills are also represented.

The reader well knows that there is scarcely any substance requiring reduction, so tough and intractable as raw bones, and he can conceive the great trial upon the strength of mills to endure the operation. The successful working of these mills upon raw bones, is abundantly shown in various manufactories in this and other cities. Their capacity and strength are extraordinary. The mills are also working upon guano, plaster, fire-brick, sumac, bark, dye-woods, ores, fish, scraps, etc., in other manufactories in this and in neighboring cities. Parties in mining interests have given these mills very considerable attention and examination, practically testing their efficiency with tons of quartz rocks and hard ores. These mills are all complete in themselves, and ready to be set up and run as they are turned out of the machine shop.

It will be somewhat difficult to indicate all the peculiar advantages to be derived from the use of sectional grinding surfaces, without a personal examination of the machine. We will, however, endeavor to give the most striking and readily appreciated advantages.

In nearly every form of iron mills heretofore in use, the grinding surfaces have been confined to a system of straight fillets or grooves. This form of dress was adopted and continued in use, not because it was the best form of grinding surface, but from the impossibility of casting a cylindrical grinder with corrugations and indentations, without making it too expensive for practical use. With such mills, having the old system of grinding surfaces, no matter what the nature of the substance to be ground, whether it was hard, greasy, tough bones, grain, plaster. or brittle minerals—all was done with the same description of surface, or at least the variance was so slight that practically the operation was the same with all. With ordinary discernment, the merest observer may see that this common way was entirely wrong. Business demands, practical and imperative in their nature, soon pointed the inventor of the Sectional Mills to the fact that changes in the system was necessary; certain results were desired, and they could only be obtained by the most thorough experiment. For grinding substances of given character, a definite configuration of surface was demanded; and as the substance to be ground varied in character and condition, so also must the appropriate surface be supplied. This general advantage was attained by having the grinding surface cast in sections. By this means any pattern of tooth suitable to the material to be ground could be furnished. The concave or shell in which the *outer* surface is placed, or the cone upon which the *inner* surface is placed, being turned upon a lathe to perfect truth of circle, insures the running of the machine with an exactness impossible to exceed by any other system.

Another great advantage in the sectional system lies in the facility with which changes can be made—no part of the body of the mill having to be removed, but merely raised sufficiently by a screw to allow the sections to be slipped to or from their places. A change made thus in a few minutes, renders very obvious the advantage over the old system. Were the inner and outer surfaces each cast in one piece, it would involve the lifting of the heavy parts of the mill, so as to allow them to be placed in the inside, taking the work of several men and a delay of several hours to accomplish. In the Sectional Mills the work can be easily done by one man.

A great advantage claimed for the Sectional Mills lies in the fact that should a piece of iron (which in grinding bones is very probable) accidentally get into the mill, and the grinding surface be broken, the broken section or sections may be removed and sound ones replaced, without the necessity of renewing the whole. Practical men will see that this is a saving of time and expense not easily over-estimated.

Fig. 2 is a sectional view of the mill, by the inspection of which its construction will be clearly perceived, in connection with the following description.

In the larger sizes the lower grinding surface of the crusher is curved, in order that iron or other foreign substances than that which the mill is working on, may be quickly discharged without injuring the dress when the pressure is made upon them; while in the smaller sizes the grinding surfaces are in a straight line, or at least not curved.

A is the top breaker, with a projecting arm. This arm is varied in shape to suit different material. It is made to slip easily over a sleeve which fits snugly on the shaft, so as to protect the shaft from abrasion from the continued jar of the breaker, and it also obviates the need of renewing that much iron with every breaker.

The large-screw nut B, is used to hold the breaker down to its place. This is a left-hand screw, and tightens itself in working.

C is the circular grinder, with holes for stud-bolts (only one of which is shown) used to tighten the grinding sections D.

E is the stationary sectional dress in the upper part of the shell, eight of which form a circle. The corrugations in these sections are made very deep, so as to admit of a great amount of wear. The lower or full sections, D, are eight in number, and are held in place by stud-bolts, one of which is shown passing through C.

The outside or stationary sections, G, are held in place by the nuts H. The circular shape of the bottom of the dresses marked D and G, admits of a great amount of wear at the bottom, where they come first in contact, and, should iron get into the mill, gives greater space on raising the lever to allow it to get out.

I, is the cone to which the dress castings, D, are attached. It has a heavy wrought-iron band around the base to support the dress, and is held in place by two feathers, L, in the shaft, and a tight collar below. Wipers, J, carry the ground material to the spout.

K is the perpendicular or main shaft, made of wrought-iron, four feet six inches long and five inches in diameter, the lower end of which, that works in the step, being made of solid steel. There are two feathers, L, let into it to hold the cone and breakers in place.

A steel, patented, conical anti-friction disk is placed under the shaft, which effectually prevents heating. The step box, which has a steel lining, is movable. The step moves up and down in a hollow column, M, in closing and opening the mill to adjust the grinding; the shaft working freely through the bevel cog-wheel N, which is supported by M. Levers for adjusting the mill with weights are shown at O. Screws are used to regulate the grinding. P is the driving cog-wheel, which, being half the size of the other wheel, doubles the power of the belt.

Q is a wrought-iron counter-shaft, three and a half inches in diameter, to which are attached the fixed and loose pulleys R, which are twenty-two inches in diameter and ten inches face.

S is the fly-wheel, weighing 500 lbs., which, with its shaft, is supported by pedestal boxes fitted with anti-friction metal.

The large screw at the top of the mill is used for raising the different parts to change the dress. In order to change the upper sections of the dress, fhe bolts T are loosened, allowing the mill to be opened at U. To change the lower grinding surface, the bolts H are unscrewed, allowing the mill to be opened at V. Then the large nut B is loosened, and the breaker and sleeve are raised. Next, the stud-bolts passing through C are unscrewed, when all the dress can be removed.

The simplicity of this arrangement, and the quickness and ease with which these changes are made, will be apparent to those who have any knowledge of mills or mill machinery.

The No. 1 Mill is intended to *crush* or prepare all hard substances for smaller mills, although a large percentage of its product does not ordinarily require another operation. The machine weighs four tons, and is constructed sufficiently strong to crush *rough raw bones, logwood* (cut in lengths of 18 inches), the *hardest quartz rock*, and all *minerals, hard guanos, slags* from furnaces, and, indeed, all substances which industrial science demands to be reduced. The hardest substance susceptible at all of grinding or breaking, can be crushed without risk of breakage of the mill. The power required to run the mill to its full capacity, is from *ten to twelve horses;* yet, its mainshaft being *solid wrought iron, five inches in diameter*, it can be attached and run safely with power of twenty-five horses. The amount of work capable of being performed in a day of ten hours is, for raw bones, twenty tons and upwards, varying with the condition of dryness; hard guanos, quartz, and other mineral substances, thirty to forty tons; plaster, fifty or sixty tons. The mill is especially adapted to the pulverization of the South Carolina deposit of guano; the grinding surface upon this may be run closely together, and a large proportion reduced to powder by the first process. Of this latter substance 25 tons may be reduced in ten hours.

MECHANICAL DESCRIPTION NO. 1 MILL. (CRUSHER.)

Full height of Mill, 7 feet 6 inches.
Size of Bed Plate, 80x48 inches.
Pulleys, 22 inches diameter and ten inches face.
Fly-wheel, 43 inches diameter; weight, 500 lbs.
Proper speed for Crusher, 400 revolutions.
Speed of Countershaft required to attain this, 200 revolutions.

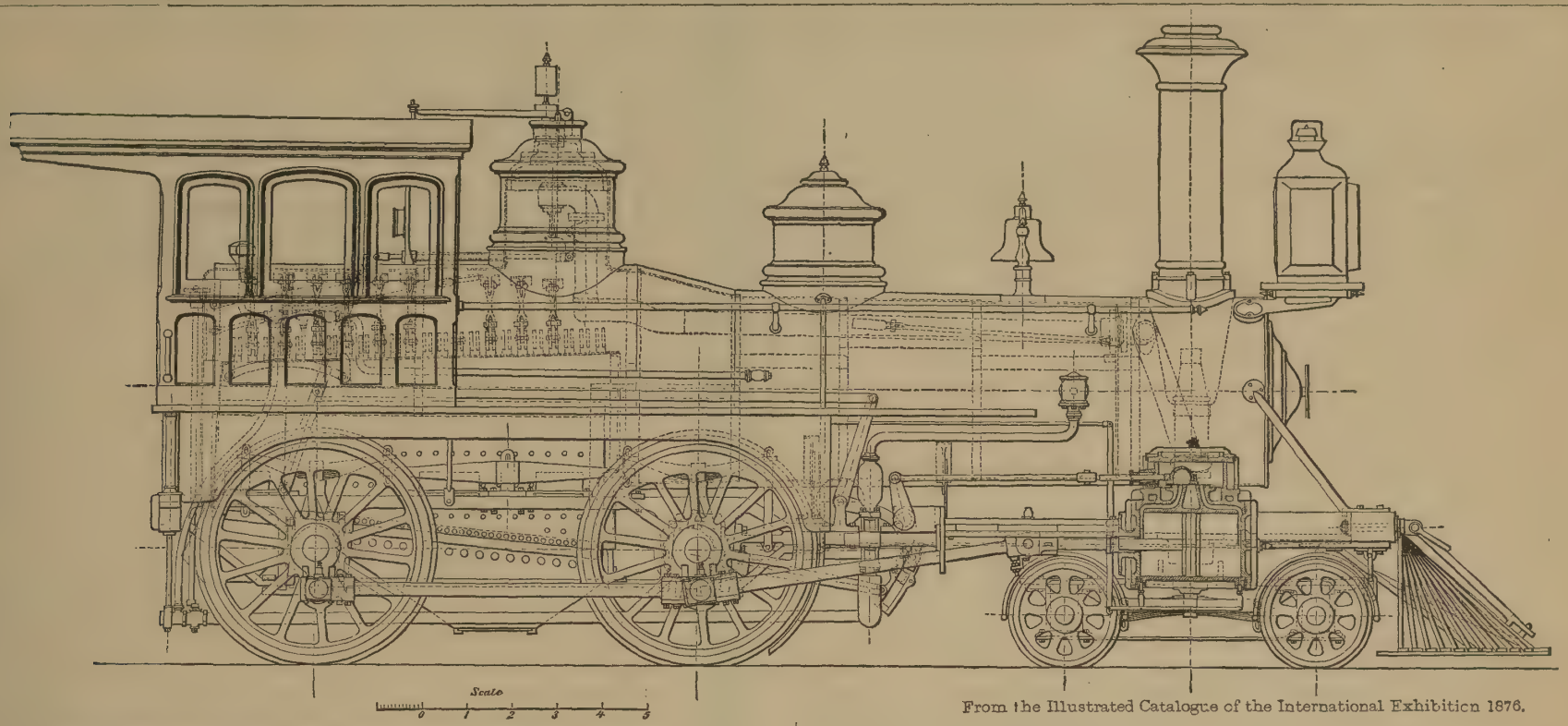
These mills are made by Messrs. Baugh & Sons, No. 20 S. Delaware Avenue, Philadelphia, and may be seen in operation in Machinery Hall, Section A—8, Column 61 and 62.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, JULY 29, 1876 NO. 4



From the Illustrated Catalogue of the International Exhibition 1876.

CENTENNIAL EXHIBIT OF BALDWIN LOCOMOTIVE WORKS.

III.

PASSENGER LOCOMOTIVE, "AMERICAN" PATTERN.

For the Central Railroad of New Jersey, four feet eight and a half inches gauge. Fuel, Anthracite Coal.

LOCATION: SECTION E 6, COLUMNS 41–42.

CYLINDERS.

Diameter	1 ft.	5	inches.
Stroke of piston	1 ft.	10	"
Length of steam-ports	1 ft.	3	"
Width of steam-ports		1¼	"
Width of exhaust-ports		2½	"
Travel of valve		5⅜	"
Outside lap of valves		¾	"
Inside lap of valves		1/32	"

Exhaust nozzles—single, high.

WHEELS.

Diameter of driving-wheels	5 ft.	2	"
Diameter of truck-wheels	2 ft.	4	"
Distance between centres of front and rear driving-wheels	8 ft.	6	
Total wheel-base of locomotive	22 ft.	5	"
Total wheel-base of locomotive and tender	44 ft.	2½	"
Diameter of driving-axle journals		7	"
Length of driving-axle journals		8	"
Diameter of main crank-pin bearing		4¼	"
Length of main crank-pin bearing		4¼	"

BOILER.

Outside diameter of smallest ring of boiler	4 ft.		"
Thickness of boiler plate (steel)		⅜	"
Number of tubes	163		
Length of tubes	11 ft.	3	"
Outside diameter of tubes		2	"
Length of fire-box inside	8 ft.	6	"
Width of fire-box inside	2 ft.	9¾	"
Depth of fire-box inside (sloping)	39–53		"
Thickness of fire-box plates (steel), side sheets		¼	"
Thickness of back sheet		5/16	"
Thickness of crown-sheet		⅜	"
Thickness of flue-sheet		½	"
Square feet of grate surface	24		
Square feet of heating surface in fire-box	112		
Square feet of heating surface in tubes	953		
Total square feet of heating surface	1065		

TENDER.

Number of wheels	8		
Diameter of wheels	2 ft.	6	"
Diameter of tender-axle journals		3½	"
Length of tender-axle journals		7	"
Capacity of tank	2200 gallons.		

WEIGHT.

Weight of engine in working order	75,000	pounds.
Weight of engine on driving-wheels	51,500	"
Weight of tender, empty	20,500	"

MATERIALS.

Boiler and Fire-Box, Hussey, Wells & Co's Homogeneous Cast Steel; *Tires*, Standard Steel Works' Crucible Cast-Steel; *Engine, Truck Wheels*, Washburn's Steel Tired Wheels; *Tender Wheels*, Taylor Iron Works' Steel Tired Wheels; *Flues*, W. C. Allison & Sons' Lap-Welded Charcoal Iron Boiler Tubes; *Injector*, Rue Manufacturing Co's "Little Giant" Injector; *Steam-Gauge and Head-Light*, Buffalo Steam-Gauge and Lantern Co.; *Brass and Copper Piping*, Benedict and Burnham Manufacturing Co.; *Jacket Iron*, W. D. Wood & Co's Patent Planished Sheet-Iron; *Stay-bolts and Tank Iron*, Catasauqua Manufacturing Co.

BISMUTH, ITS PRODUCTION AND USES.

As a useful supplement to our recent publication of certain correspondence relating to the discovery of a deposit of bismuth of great magnitude, near the town of Beaver, in Utah Terr., the following statement of the production and uses of this metal, from the pen of a correspondent of the *Engineering and Mining Journal*,* will be found to contain some facts of interest, viz :—

Bismuth is a hard, brittle metal of a reddish white color. It is found generally in the metallic state in quartz-rock, or disseminated through gneiss and clay slate. The principal localities in which it is mined are Saxony, Transylvania and Bohemia, and recently in Peru. In this country specimens have been found in Monroe Co., N. Y., in South Carolina, at Haddam, Conn., and in Virginia. A deposit of oxide and sulphide of bismuth occurring in fissure veins is claimed to have been discovered recently, near Beaver City, Utah Terr. [See *Polytechnic Review*, i, 29.]

The uses of the metal are limited. Its property of increasing the fusibility of those metals with which it is combined, has led to its use in the preparation of various alloys. An alloy composed of two parts of bismuth, one of lead, and one of tin, fusible at 200° Fahr., is used by die sinkers to test the perfection of their dies. Soft solder for pewter is composed of one part of bismuth, two of tin, and one of lead. An alloy of five parts of bismuth, two of tin and three of lead, melts at 199° Fahr., and is known as stereotype metal. An amalgam of twenty parts of bismuth and eighty parts of mercury, is used for silvering the interior of glass globes.

Of the salts of bismuth, only two are commercially important, the basic nitrate and the oxychloride. The former is employed medicinally. It is obtained by dissolving the metal in nitric acid, and precipitating with water. It is known as "flake white," and, mixed with tin and tartar, it is employed as a mordant for dyeing lilac and violet in calico printing.

The oxychloride is obtained by dissolving the metal in nitric acid, and pouring into it a solution of common salt. It is known as "pearl-white," and is extensively

*See that Journal, xxi, 582.

employed for enamels on porcelain, and also for gilding. Owing to its great solvent properties with other oxides, especially with silica and borax, to which it imparts no color, it is valuable in the manufacture of porcelain and optical glass. Its principal use, however, is as a cosmetic, to give artificial freshness to faded complexions. Sulphur turns this black. Ladies who make use of it, should therefore avoid sulphur baths, and the neighborhood of impure illuminating gas.

The amount of bismuth annually consumed in the United States, does not exceed ten tons, the larger portion being employed in the preparation of the sub-nitrate. It is but very little used, at present, in the metal manufacture, owing to its high price, which is now 5*s.* 3*d.* per lb. in London, and about $1.75 per lb. here.

When the Peruvian deposits were discovered, and ore from them sent to England, a combination is said to have been made between their owners and those of the Saxon mines, to control the trade and maintain prices on the basis of an equal distribution of sales. Should the price of bismuth be materially lowered, however, an impetus would undoubtedly be given to its use in the manufacture of alloys; but even then it is doubtful if more than fifteen or twenty tons a year could be sold in this country. [O. H.]

We have but one comment to make upon the interesting communication of our contemporary's correspondent, namely; to express the opinion that the limitation of the possible utility and probable consumption of the metal in question, in the event of its being placed upon the market in abundance and at a comparatively low price, is a somewhat hazardous prediction, warranted by neither fact nor analogy.

As a useful addition to what has preceded, we append, in conclusion, an extract from *Guettier's Metallic Alloys*, concerning bismuth alloys:

"*Alloys of Bismuth and Copper.*—These alloys are easily effected, notwithstanding the difference in the points of fusion of the two metals. They are brittle, and of a pale red color, whatever the proportions employed. The specific gravity of the alloys is sensibly equal to the average of the two metals.

"*Alloys of Bismuth and Zinc.*—These alloys are seldom made, and produce a metal more brittle, presenting a larger crystallization, with less adherence, than zinc or bismuth taken singly. On that account they are useless in the arts.

"*Alloys of Bismuth and Tin.*—The combinations of bismuth and tin take place easily, and in all proportions. A very small quantity of bismuth imparts to tin more hardness, sonorousness, lustre, and fusibility. On that account, and for certain applications, a little bismuth is added to tin order to increase its hardness. However, bismuth being easily oxidized, and often containing arsenic, the alloys of tin and bismuth would be dangerous for the manufacture of certain domestic implements, such as culinary vessels, pots, etc.

"The alloys of bismuth and tin are more fusible than each of the metals taken separately.

"An alloy of equal parts of the two metals is fusible, according to several authors who disagree, at a temperature varying from 100° to 150° Centigrade. These differences are evidently due to an incorrect measuring of the temperature, or to the temperature being taken after the proper time of fusion.

"When tin is alloyed with as little as 5 per cent. of bismuth, its oxide acquires the peculiar yellowish-gray color of the bismuth oxide.

"According to Rudberg, melted bismuth begins to solidify at 264°, and tin at 228°. For the alloys of the two metals the "constant point" is 143° C."

"*Alloys of Bismuth and Lead.*—These two metals are immediately alloyed by simple fusion, with merely the ordinary precautions. The alloys are malleable and ductile as long as the proportion of bismuth does not exceed that of lead; they are also much more tenacious than lead.

"The alloy of bismuth 2, and lead 3 parts, is about ten times harder than pure lead.

"The compounds of bismuth and lead generally have a dark gray color, with a tint intermediate between the color of tin and that of lead. Their fracture is lamellar, and their specific gravity greater than the mean specific gravity of either metal taken singly.

"An alloy of equal parts of bismuth and lead has a specific gravity equal to 10·71. It is white, lustrous, sensibly harder than lead, and more malleable. The ducility and malleability diminish with an increased proportion of bismuth, while they increase with the excess of lead in the alloy.

"An alloy of bismuth 1 and lead 2 is very ductile, and may be laminated into thin sheets without cracks. Bertheir says its point of fusion is 166° C.

"According to Rudberg, melted lead beginning to solidify at 325°, the 'constant point' for the alloy of the two metals is 129° C.

"*Alloys of Bismuth and Iron.*—The learned disagree as to the possibility of combining bismuth and iron. Up to the present day, the combinations indicated are rather doubtful.

"At all events, the principal fact is, that the presence of bismuth in iron tends to render this metal brittle, and is not an improvement in its manufacture.

"*Alloys of Bismuth and Antimony.*—These alloys are grayish, brittle, lamellar, like the alloys of bismuth and zinc, and present no real utility in the arts.

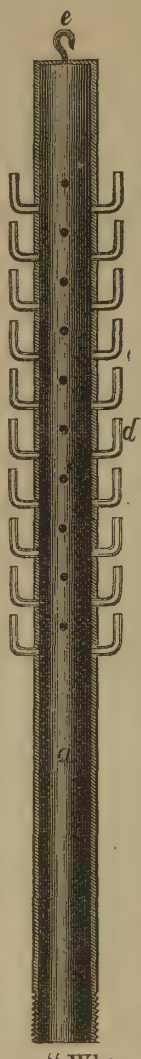
"*Alloys of Bismuth and Nickel.*—As with the preceding combinations, we are not aware of any interesting application of the alloys of bismuth and nickel.

"*Alloys of Bismuth and Arsenic.*—These alloys are more brittle and more fusible than bismuth. This metal, which is found in nature combined with arsenic, appears to have little affinity for it, when we make alloys. Nothing practical has been accomplished in the alloys of bismuth and arsenic. Arsenic is rapidly volatilized, and the very small proportion which is absorbed by bismuth is easily oxidized. Therefore the many difficulties attending the formation of the alloy, which in itself presents little interest, have prevented further examinations.

"*General Observations.*—It will be seen from the preceding data, that the alloys of bismuth are not at the present time important in the arts, excepting the fusible alloys made of bismuth and certain white metals, such as tin, lead, etc. The alloys of bismuth with tin, the latter predominating, seem to be the most interesting. The great fusibility of the alloys of bismuth and lead will have the effect of popularizing these alloys, and also those with tin, as soon as bismuth can be obtained in abundance and at a less cost.

"To sum up, the action of the bismuth in alloys is to increase their hardness, fusibility, and brittleness. But, although bismuth renders brittle the metals with which it combines, it does so to a considerably less degree than arsenic or antimony." W.

SHAW'S EXHAUST NOZZLE, FOR QUIETING THE NOISE OF SAFETY VALVES, ESCAPE PIPES, &C.



"One of the first results of this Nozzle is its quiet manner of exhausting; being free from all that sharp shooting sound that frightens horses, and alarms the people, and prevents the locomotives from entering near the center of cities and towns and restricts their usefulness to that extent; and forces railroad companies to employ expensive teams, whose length often exceed that of the cars, to the great obstruction of the highways, which causes them to be considered a great nuisance, and which forces still further restrictions upon the railroads and prescribes more narrow limits of operations.

"The same nozzle, applied to the pop or safety valves, destroys the noisome sound, which is considered the most disagreeable noise about the engine. Upon steamboats, that horrid roar from the safety valve pipes can be quieted without any detriment or obstruction, and its application will enable persons to communicate with each other upon a wharf or steamboat when the steam is blowing off. And at sea, and in our bays and rivers, it will enable the captain to be heard when the engines are slowed down by a vessel running across bows, coming to wharf, or for any other reason that causes the engines to be slowed down and the safety valves to fly up. Many a fog bell or fog horn, or the human voice, might have been heard, and lives and property saved, but for the continual roar of steam in the hour of great emergency. Every commander that has been in action knows that the roar of steam from the boilers drowns his voice when it is most needed, and that various complicated methods have been tried to get rid of the noise, unattended with success. The value of the comfort of passengers and others at wharf is too great to be estimated in dollars and cents. This exhaust nozzle quiets all the objectionable noise without any interference whatever.

"The cut represents a vertical section through centre of nozzle, which consists of a plain brass or iron pipe (a), provided with a screw thread or flange at its lower end for attachment to safety-valve pipe. The upper end is closed by cap (e). The sides of tubes are bored and tapped for numerous small tubes (d), that are placed in sufficient quantity to equal the number of square inches of outlet desired.

"The small tubes permit a free and unobstructed flow of steam, and retards and absorbs all noisome sounds. The shape of the nozzle can be variously fashioned to adapt to different purposes without any alteration.

"When applied within smoke-stacks the draft is increased with same area of outlet; on this account a much larger area of outlet is given, making a much freer exhaust."

For further information address patentee, T. Shaw, 915 Ridge Av., Philadelphia.

MODERN FIRE ENGINES.

VII.

PUMPS—CONTINUED.

The pump of the "BUTTON" engine as now made (see Figs. 31 and 32) is horizontal, double-acting, and "variable." The valve plate is circular, and is placed upon the upper side of the pump. The valves are arranged in concentric circles; those on the outer circle (12 in number) being for suction, and those on the inner (6 in number) being for discharge; all being circular *rubber* disks. The piston is composed of two concentric hollow plungers, the outer one being bored true so as to serve as a small pump cylinder in which the inner and smaller plunger may act when great force is required. The change is made by a slight turn of the outside plunger, which fastens it to lugs in the pump shell, and leaves the inside plunger free.

In the second class Button engine, the stroke is 5½ inches; the larger plunger has a diameter of 9 inches (area 63·6 sq. in.), and the inner plunger is 7 inches in diameter (area 38·5 sq. in.)

The position of cylinder and pump in a Button Engine is shown in Fig. 26, taken from "Roper's Hand Book of the Steam Fire Engine."

The HUNNEMAN engine has an upright double-acting pump with an outer shell divided longitudinally into two equal vertical compartments. One of these (that on the suction side) is divided into three chambers by two horizontal partitions or valve plates. The discharge compartment is divided by a horizontal plate; the discharge valve-plate being vertical and circular, half over each side of this latter partition. The valves are rubber poppets, eight suction and two discharge. At each up and each down stroke the water passes four suction and three discharge valves.

The JUCKET second-class engine has two double-acting vertical plunger pumps. Each of these has a valve-shell square in section, divided vertically by a horizontal partition. One face carries eight suction-valves; the opposite face, eight discharge-valves, these being rubber poppets each 3¼ inches diameter. The plungers are each 4¼ inches diameter, 8-inch stroke. The crank shaft is divided and so coupled that either pump may be run separately if desired.

The "HARREL" engine is said to use the Jucket pump substantially as described.

The PARRY pump was single, horizontal and double-acting; took the suction from the under side through long clack-valves with short lift, arranged in slats on inclined seats; the discharge valves were similar slats, and opened directly into the air chamber. In the first class engines there were 12 suction valves, each 12 inches long, with ¼-inch lift, and 6 discharge valves; plunger was metal, packed with cup-leathers. A first class pump had 6-inch bore and 16-inch stroke.

The pump used by Messrs. Shand, Mason & Co (London) in their vertical engines, is of the "bucket and plunger" pattern. The valves are rubber poppets. In action

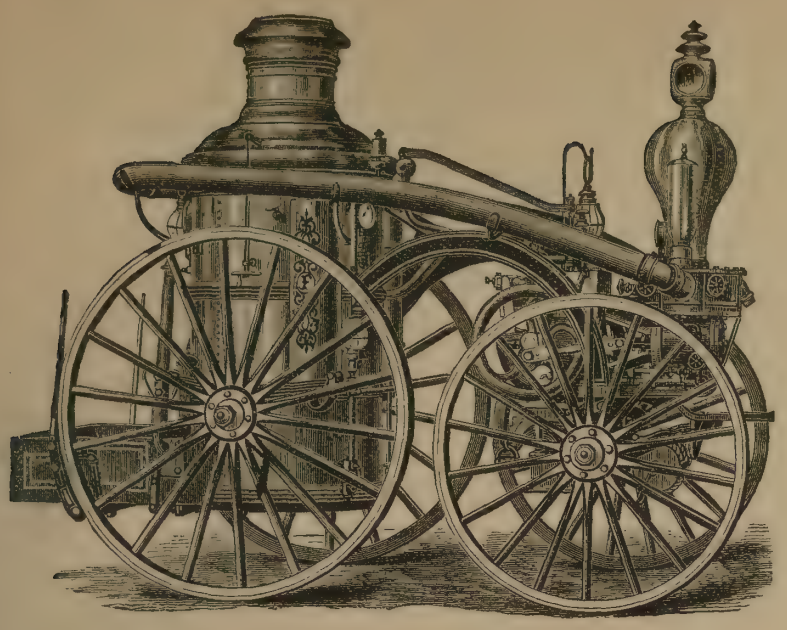


Fig. 30—THE "BUTTON" ENGINE.

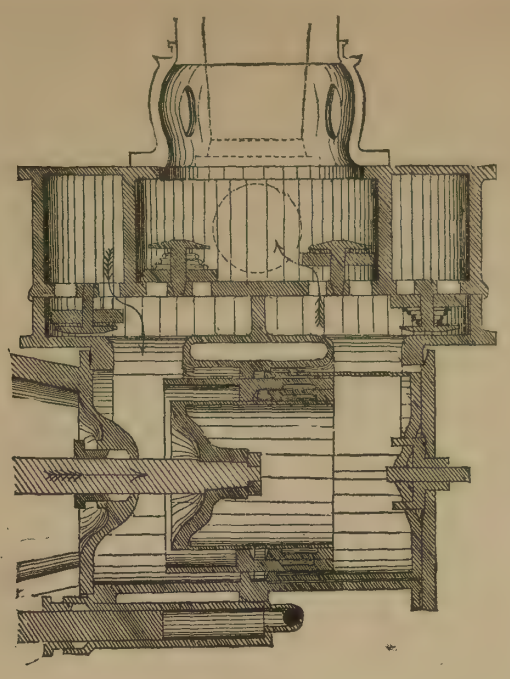


Fig. 31.

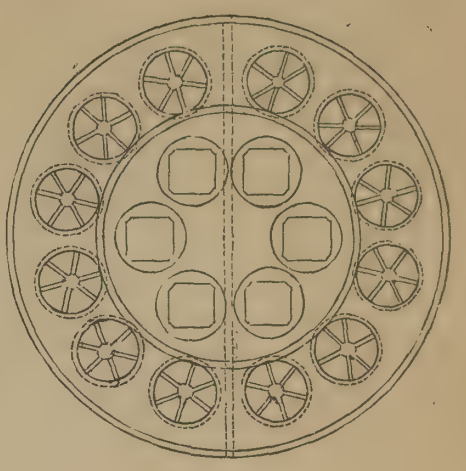


Fig. 32.

the suction is drawn in the up-stroke by the bucket, and in the down stroke about half the water is discharged by the displacement of the plunger, and at the next up-stroke the remainder of the water is discharged by the ascent of the bucket. The connecting rod is jointed to the bottom of the pump plunger, which is itself attached to the steam piston by two piston-rods, between which the crank works. To renew or examine the valves, the suction chamber is unscrewed, and the pump cylinder unbolted from the flange on the pump-head, thus leaving the bucket exposed, but suspended to the connecting-rod; the bucket is removed and the valves exposed in it by unscrewing the lower nut of the bucket. The valves are rubber poppets, $2\frac{3}{4}$ inches diameter, with $\frac{3}{8}$ inch lift, giving an area of about 21 square inches for the seven suction valves, and about 18 square inches for the six discharge valves.

In the horizontal engines of Shand, Mason & Co., the piston-rod has a slotted cross-head, in which the crank-pin works. The pump is a double-acting plunger.

The engines built by Merryweather & Sons, London, have horizontal steam cylinders and pumps, with long slow stroke. The slide-valves are piston-valves, so arranged that a cross-head attached at one end on a flat twisted spiral bar with the required amount of turn, actuates, at the proper moment, by means of short levers keyed on the bar, the steam and exhaust slide.

In the double cylinder engines each piston brings itself to rest by closing its own steam and exhaust-ports; the other piston-rod then acts on a valve which admits steam to the slide which is at rest, causes it to complete its travel and reverse the steam to the first cylinder, thereby giving the return stroke. Each piston commences its stroke before its neighbor is brought to rest. In the single cylinder engines, the piston brings itself to rest by momentarily shutting off the ports; but at the same time it opens a small steam-valve, which completes the stroke of the *slide* after the piston is brought to rest, and thus gives the return stroke. There are no fly-wheels or cranks; no "dead point;" they may be worked fast or slow, and started or stopped at any point in the stroke.

The steam fire engines built by Wm. Roberts, of Millwall, England, have quick steam-stroke and slow pump-stroke. The cylinder is placed vertically, and a cross-head, keyed to the piston-rod, is connected by side rods to the levers working the pump pistons. A short connecting-rod, attached to one of the levers, works the fly-wheel and shaft with eccentric for moving the steam slide. One of these levers is a bell-crank. The stroke of the pump-buckets is rather less than a fourth the stroke of the steam piston. In each end of the pump, one above and one below, are the buckets, having a fork to each, which act as guides, and are connected to the cross-head by links. As the piston travels up and down, the buckets recede and advance; thus, as the lower bucket rises it lifts the water through the upper bucket, and discharges a volume due to the diameter of the bucket and length of stroke; upon the return stroke of the engine the upper bucket rises and delivers its volume of water, and at the same time fills the lower chamber, ready for the next stroke of the lower bucket. The water is constantly flowing through the suction hose and pump in one unbroken line. Each bucket is a grating, having a disk valve of large diameter and small lift, and the buckets, valves, forks, and links are duplicates of each other. The upper bucket is accessible by removing the air-chamber, and the lower one by taking off the cap at the bottom. The valves used by Mr. Roberts are rubber disks, $\frac{5}{8}$ inch thick, $7\frac{3}{4}$ inches diameter, with a lift of $\frac{1}{2}$ inch, giving an area of 12·17 square inches; both suction and delivery being the same.

G.

SOME FACTS CONCERNING MATCHES.

(*Concluded.*)

Another, and perhaps more serious, because unpreventable objection to the phosphorus match, is its liability to accidental ignition, by which property and life are frequently destroyed or endangered. Against this form of danger, no amount of precaution will secure immunity. Being universally employed, and in every conceivable situation, and igniting with very slight friction, they are liable to be accidentally rubbed against, or unconsciously trodden upon, to the imminent peril of property and person; while rats and mice attracted, as it appears, by the odor of the phosphorus, not unfrequently carry them off to their inaccessible hiding places, where their ignition is almost invariably peculiarly dangerous.

To fully appreciate the trouble which this indispensable little article gives rise to, we must refer the reader to the statistics of fires and their causes, which are published annually by the proper authorities of our large cities and towns. For our purpose, it will suffice to refer to certain tabulated figures recently published in the excellent report of a "Committee on the Origin of Fires" made to the "National Board of Fire Underwriters." From these figures it appears that in the eight principal cities of the Union, there occurred during the year 1875, 214 fires from matches, the losses from which will certainly aggregate several millions of dollars.

It will, therefore, be readily admitted that the introduction and general adoption of a substitute for the phosphorus match that will possess valuable properties of the latter unimpaired, while it is free from the qualities that render the phosphorus match objectionable, is a subject of great importance; and in view of the numerous efforts that have been made to effect this innovation, it behooves us to give the claims of the various substitutes that have been devised a careful consideration.

The substitutes for the common phosphorus match are generally of two kinds. The one class, which is slowly growing in popularity, will ignite *only* on a certain chemically prepared surface; there is no phosphorus on the match itself, but this substance is contained in the prepared surface referred to. To the other class belong matches containing no phosphorus in their composition, but which, like the common match, ignite by friction on any surface. The matches of the first-class are made generally of a mixture of chlorate of potassa and sulphide of antimony, made into a paste with some suitable binding material; while the rubbing surface is composed of amorphous phosphorus (to which emery or other gritty substance has been added) applied with the aid of glue, or its equivalent, to the surface of the wooden or paper box, or in some cases at the other end of the match. In the latter case, it is necessary to break the match in half and rub the two ends together.

Matches of the second class—matches igniting by friction on any surface, but containing no phosphorus—have been made from chlorate of potassa and hyposulphite of lead; chlorate, sulphide of antimony and red lead; and from other chlorate mixtures with metallic sulphides or free sulphur, and in some cases, a percentage of a chromate or nitrate.

The evolution of the pungent and deleterious fumes with which we are so familiar in the common sulphur-tipped match, has given rise to the production of anti-sulphur matches in which the free sulphur is replaced by fat, wax or stearic acid; these matches have the further advantage that the stick is at once ignited with the head, while with the sulphur match, the sulphur is almost entirely consumed before the wood ignites. These matches require, however, a more energetic oxidizing agent than the common matches, and are also more expensive. The same remarks hold good of the wax matches.

Matches that will ignite only on a specially prepared surface, and that will be useless without this surface, possess very decided and obvious advantages. They cannot be accidentally ignited, save under the rarest concurrence of circumstances; they may be rubbed, played with by children, trodden upon unconsciously, carried off by rats or mice, without the slightest liability to accidental fire; and on the score of convenience, which is also worthy of consideration, although their use requires also that the chemically prepared surface be carried with them, this is no more troublesome to do than to carry the matches themselves.

Matches of this description have been known for a number of years, and are now manufactured more or less extensively in Sweden, Germany, France, England and the United States. The headquarters of this trade, however, has thus far been Sweden, where, as has been remarked, their use is made compulsory, and none others are permitted to be used or manufactured.

It may, however, be proper to add just here that the product of the numerous manufacturers of safety matches, is by no means equally good. Some samples of what purported to be Swedish safety matches, that the writer has examined, were not strictly what they professed to be, and could generally be ignited by vigorous friction against a surface of common pine wood. Certain English matches of the same character, likewise, although they could not be ignited like those just named upon wood, were nevertheless easily set off when rubbed upon paper. These facts suggests very strongly, in spite of the label on the boxes, the presence of some phosphorus in the composition; but it is most likely that the bulk of the so-called safety matches made abroad are what they profess to be, and will only ignite on the specially prepared surface. In this country, of late, there has been quite an impetus given to the pro-

duction of such matches, and if we may judge from the samples of goods that have come under our notice, our manufacturers have not only nothing to learn in this direction from their foreign competitors, but have really succeeded in producing an article in every respect excellent, and in several respects superior to similar products made abroad.

The opportunity for forming a judgment of comparative excellence in this branch of manufacture, has been afforded by the examination of these products as displayed at the Centennial Exhibition, when Swedish, English and American samples are shown.

The American Safety Fusee Company, Limited, of Erie, Pennsylvania, especially makes a large and special exhibit of this class of articles, (safety matches and fusees) and their products will bear a favorable comparison with anything of the kind produced elsewhere.

But while the safety match affords security from danger in a great variety of forms, and is therefore deserving of approval and encouragement by every legitimate means that will favor its introduction into general use, it must not be supposed that it affords security against every form of accident. There is one species of danger that no amount of ingenuity can completely guard against, and that annually costs the country an enormous total of losses by fire—namely, carelessness. Against this source of danger, which, like incendiarism—introduces the personal equation—the safety match can only be partially efficacious. To be completely efficacious, would be to assume that it lies within the power of the maker of safety matches, to make prudent men of fools, and honest ones of rogues.

Let us fairly acknowledge the eminent utility of the safety match, in that it is an admirable inculcater of carefulness, by the unconscious corrective influence which its use imposes upon those who are habitually or constitutionally careless, and in that it practically removes a host of dangers to person and property.

To conclude a somewhat detailed sketch, we would urge, as a measure of enlightened public policy, that the substitution of the so-called safety matches be encouraged by every legitimate means that can be brought to bear. We do not feel prepared to advocate the doing away with the common matches by legal enactment, although no one who gives the subject careful consideration can doubt but that such action would prove of substantial benefit in the annual saving of a vast amount of property against loss by fire. In Sweden, it appears the Government has wisely taken the step of enforcing the exclusion of the phosphorus match. With us, however, it may well be doubted whether the exercise of such a paternal spirit, on the part of the constituted authorities, would not be construed into an act of tyrannical interference, which would arouse great opposition. The remedy that can be most efficiently applied, however, is in the hands of a body whose interests are directly concerned in applying it—namely, the fire underwriters; for though they may find it unadvisable and inexpedient to discriminate systematically against the common matches by a reduction of rates in favor of the safety matches, they can, nevertheless, by giving the latter their moral support, and publicly pronouncing their preferences, contribute most effectually to the accomplishment of the desired end, by assisting in the manufacture of public opinion.

THE MECHANICAL ACTION OF LIGHT.

A Lecture delivered at the Royal Institution, London.

BY W. CROOKES, F. R. S.

IV.

I will now, by means of a vertical lantern, throw on the screen the projection of one of these instruments, so as to show the movement rather better than you could see it on the table. The electric light falling vertically downwards on it, and much of the power being cut off by water and alum screens, the rotation is slow. I bring a candle near and the speed increases. I now lift the radiometer up, and place it full in the electric light, projecting its image direct on the screen, and it goes so rapidly that if I had not cut out the four pieces of pith of different shapes you would have been unable to follow the movement.

The speed with which a sensitive radiometer will revolve in the sun is almost incredible; and the electric light such as I have it in this lantern cannot be far short of full sunshine. Here is the most sensitive instrument I have yet made, and I project its image on the screen, letting the full blaze of the electric light shine upon it. Nothing is seen but an undefined nebulous ring, which becomes at times almost invisible. The number of revolutions per second cannot be counted, but they must be several hundreds, for one candle has made it spin round forty times a second.

I have called the instrument the radiometer because it will enable me to measure the intensity of radiation falling on it by counting the revolutions in a given time; the law being that the rapidity of revolution is inversely as the square of the distance between the light and the instrument.

When exposed to different numbers of candles at the same distance off, the speed of revolution in a given time is in proportion to the number of candles; two candles giving twice the rapidity of one candle, and three, three times, etc.

The position of the light in the horizontal plane of the instrument is of no consequence, provided the distance is not altered; thus two candles, one foot off, give the same number of revolutions per second, whether they are side by side or opposite to each other. From this it follows that if the radiometer is brought into a uniformly lighted space it will continue to revolve.

It is easy to get rotation in a radiometer without having the surfaces of the disks differently colored. Here is one having the pith disks blacked on both sides. I project its image on the screen, and there is no movement. I bring a candle near it, and shade the light from one side, when rapid rotation is produced, which is at once altered in direction by moving the shade to the other side.

I have arranged here a radiometer so that it can be made to move by a very faint light, and at the same time its rotation is easily followed by all present. In this bulb is a large six-armed radiometer carrying a mirror in its centre. The mirror is almost horizontal, but not quite so, and therefore when I throw a beam of electric light vertically downwards on to the central mirror, the light is reflected off at a slight angle, and as the instrument rotates its movement is shown by the spot of light travelling round the ceiling in a circle. Here again the fog helps us, for it gives us an imponderable beam of light moving round the room like a solid body, and saving you the trouble of looking up to the ceiling. I now set the radiometer moving round by the light of a candle, and I want to show you that colored light does not very much interfere with the movement. I place yellow glass in front, and the movement is scarcely diminished at all. Very deep colored glass, you see, diminishes it a little more. Blue and green glass make it go a little slower, but still do not diminish the speed one-half. I now place a screen of water in front: the instrument moves with diminished velocity, rotating with about one-fourth its original speed.

Taking the action produced by a candle flame as 100

Yellow glass reduces it to				89
Red	"	"	"	71
Blue	"	"	"	56
Green	"	"	"	56
Water		"	"	26
Alum		"	"	15

I now move the candle a little distance off, so as to make the instrument move slower, and bring a flask of boiling water close to it. See what happens. The luminous index no longer moves steadily, but jerks. Each disk appears to come up to the boiling water with difficulty, and to hurry past it. More and more sluggishly do they move past, until now one has failed to get by, and the luminous beam, after oscillating to and fro a few times, comes to rest. I now gradually bring the candle near. The index shows no movement. Nearer still. There is now a commencement of motion, as if the radiometer was trying to push past the resistance offered by the hot water; but it is not until I have brought the candle to within a few inches of the glass globe that rotation is recommenced. On these pith radiometers the action of dark heat is to repel the black and white surfaces almost equally, and this repulsion is so energetic as to overcome the rotation caused by the candle, and to stop the instrument.

With a radiometer constructed of a good conductor of heat, such as metal, the action of dark heat is different. Here is one made of silvered copper, polished on one side and lampblacked on the other. I have set it moving with a candle slightly the normal way. Here is a glass heated so that it feels decidedly warm to the hand. I cover the radiometer with it, and the rotation first stops, and then recommences the reverse way. On removing the hot shade the reverse movement ceases, and normal rotation recommences.

If, however, I place a hot glass shade over a pith radiometer the arms at once revolve the normal way, as if I had exposed the instrument to light. The diametrically opposite behavior of a pith and a metal instrument when exposed to the dark heat radiated from a hot glass shade is very striking. The explanation of the action is not easy, but it depends on the fact that the metal is one of the best conductors of heat, whilst pith is one of the worst.

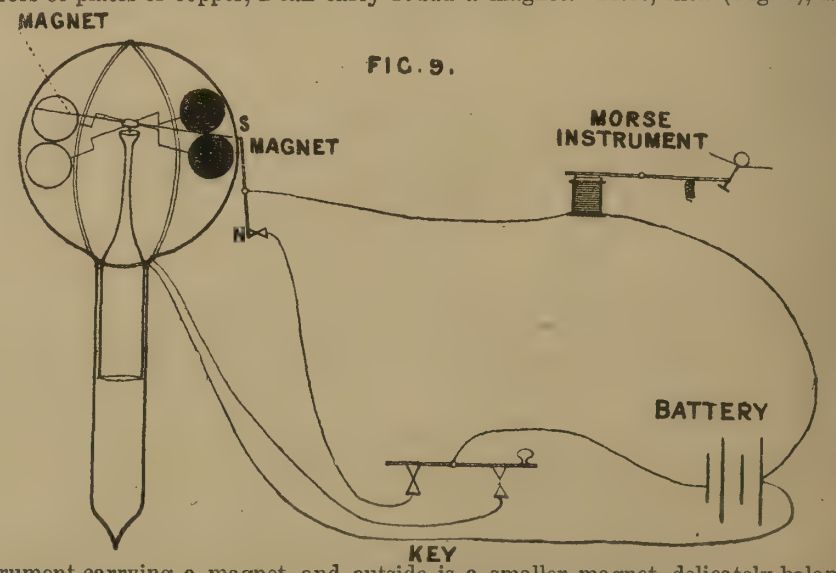
One more experiment with this metallic radiometer. I heat it strongly with a spirit-lamp, and the arms spin round rapidly. Now the whole bulb is hot, and I remove the lamp: see what happens. The rotation quickly diminishes. Now it is at rest; and now it is spinning round just as fast the reverse way. I can produce this reverse movement only with difficulty with a pith instrument. The action is due to the metal being a good conductor of heat. As it absorbs heat it moves one way; as it radiates heat it moves the opposite way.

At first I made these instruments of the very lightest material possible, some of them not weighing more than half a grain; and where extreme sensitiveness is required lightness is essential. But the force which carries them round is quite strong enough to move a much greater weight. Thus the metallic instrument I have just experimented with weighs over 13 grains, and here is one still heavier, made of four pieces of looking-glass blacked on the silvered side, which are quickly sent round by the impact of this imponderable agent, and flash the rays of light all round the room when the electric lamp is turned on the instrument.

Before dismissing this instrument let me show one more experiment. I place the looking-glass and the metal radiometer side by side, and, screening the light from them, they come almost to rest. Their temperature is the same as that of the room. What will happen if I suddenly chill them? I pour a few drops of ether on each of the bulbs. Both instruments begin to revolve. But notice the difference. Whilst the movement in the case of the metal radiometer is direct, that of the looking-glass instrument is reverse. And yet to a candle they both rotate the same way, the black being repelled.

Now, having found that this force would carry round a comparatively heavy weight, another useful application suggested itself. If I can carry round heavy mirrors or plates of copper, I can carry round a magnet. Here, then (Fig. 9), is an

FIG. 9.



instrument carrying a magnet, and outside is a smaller magnet, delicately balanced in a vertical position, having the south pole at the top and the north pole at the bottom. As the inside magnet comes round, the outside magnet, being delicately suspended on its centre, bows backward and forwards, and, making contact at the bottom, carries an electric current from a battery to a Morse instrument. A ribbon of paper is drawn through the "Morse" by clockwork, and at each contact—at each revolution of the radiometer—a record is printed on the strip of paper by dots; close together if the radiometer revolves quick, farther apart if it goes slower.

(To be continued.)

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The English Channel Tunnel will have to compete in traffic with lines of vessels traveling almost as fast as a railway train, and almost as steadily as a Pullman car. It will be a question between open air and submarine traveling, at about the same speed.—Query, whether the enterprise will pay? [Tenor of an article in London *News.*]

The Largest Bridge in the World is the Chenat R.R. bridge, British India, completed last December, after four year's work. It has 64 spans, each of 132 feet, making its entire length 9,300 feet. The masonry is all of brick, 5,000,000 cu. ft. in quantity. The girders weigh 9000 tons. [*Eng. News*, iii, 219.]

Porcelain Roller Mills are recommended by the *Muhle* for crushing semolina, and also for crushing wheat prior to grinding. They are claimed to damage the bran little, to absorb little power, and to give good products.

Philadelphia-Made Pulleys, Couplings, and Shaftings, and general shop usage in the transmission of power, are receiving high commendation from visiting engineers.

The First American Canal was from Middletown, on the Susquehanna, to Reading, on the Schuylkill; being 79 miles in length, with a navigable feeder of 7 miles. It was surveyed in 1762 by David Rittenhouse and Dr. Wm. Smith, although said to have been suggested by Penn in 1690; was commenced in 1764, and completed in 1837. [Abr. from *Lebanon Times.*]

Modern Engineering Feats.—Extensive arms of the sea, in Holland, have been drained; the Suez Canal constructed, and the estuary of the Mississippi deepened. It is proposed to admit the Mediterranean into two extensive tracts of the Sahara, giving water communication to Algeria, and making a sea-port of Timbuctoo.

Mr. Spaulding, an American, proposes to turn the Black Sea into the Caspian, giving the latter its ancient body of waters, by a channel 150 miles long and with a maximum width of 170 yds. The projector calculates that in 40 years the level of the two seas would be so nearly uniform that the navigation of the new channel could begin. The bed of the Black Sea would be made a highway of commerce; the rainfall near the Caspian increased.

Mr. Spaulding also proposes to join the Don to the Volga, thus laying the sea of Azof under contribution. The Russian Government appears to desire investigation of the scheme. [Ab. from *Hyd. Engineer*, i, 113.]

Sewage of the West Riding Towns.—The rivers and watercourses of the Black Country, Lancashire, and of the West Riding of Yorkshire, are pestilent open sewers. Sheffield, Rotherdam, Chesterfield, Bamsley and other towns empty their sewage into the Don, whose waters, lower down, are used for drinking purposes by the people of Doncaster. These last have threatened the up-stream contaminators with injunctions, and have stirred them to activity. Mr. Webster, of Sheffield, proposes an outfall sewer from Sheffield to Thorne, 30 miles, receiving the sewage of the towns on its line; the sewer to follow the course of the Don, with a fall of six ft. per mile to Doncaster, and thence 18 inches per mile to Thorne. The estimated cost to Sheffield alone is £500,000, including the purchase of 3,000 acres of land at £20; which could be gradually paid off by the working of the sewage farm. [Abr. from *Hyd. Engineer*, i, 117.]

Steam Street Cars for Baltimore.—It is proposed to use in this latter city the steam street cars made by the Baldwin Locomotive Works of this city, and illustrated in our issue of Apr. 10.

Chinese Railroad.—The Woosung Railway having received Imperial protection from Pekin, approaches completion. It excites the wildest curiosity; crowds flocking to see the little "Pioneer" locomotive hauling ballast, etc. [Abr. from *North China Daily News.*]

Rendle's System of Glazing (described in *Engineering* xxii, 9), consists of a series of zinc bars of pot-hook section, with a return bend; the bars being screwed to the purlins. The top bar is simply of pot-hook section, and the bottom bar, the same section reversed. The glass rests in the groove of the lower bar and in the back groove of the intermediate and upper ones, in which it has full vertical play. The panes lap each other; no water can penetrate the roof (as was tested by a fire hose); water from the *inside* is carried down by the grooves; the panes are rigid, although readily fixed and replaced. At Paddington there are 15,000 sq. ft. under roof, and Mr. Rendle is under contract to cover several more large stations.

Iron Cars and Car Frames in Europe.—Early cars were of wood, without buffers; these last, and traction springs, were then introduced; later, the bending of the sills was partly remedied by reinforcement with plate iron ·4 to ·6 inches thick. This was next replaced by rolled iron; next the wooden buffer beams were replaced by iron; now the use of iron cross-beams is general. Wooden cars of 22,000 lbs. capacity cost $22 gold for annual maintenance, and last 16 years.

On various Belgian lines, the average cost of maintenance of iron cars for carrying coal is but 15 cts. yearly. [Q'y? *Ed.*] The life of an iron car cannot yet be stated, there being but 15 years' experience; although one covered car entirely of iron was made 30 years ago and is still in perfect condition. No more of this class were constructed on account of the great heat in cars of this construction.

In Germany, iron cars for freight are widely used, with good opinions; repairs being less, safety greater, and derailments less frequent, on account of the parallelism of the axles. In Upper Silesia there were, in 1867, 1200 iron cars in service; in the Saarbrück roads, 1000. The former weigh about 12,100 lbs.; the latter a little less. The dead weight of these cars of 22,000 lbs. capacity generally exceeds that of wooden cars. In Belgium they weigh but 10,100 to 10,500 lbs. The German builders use four sills; two being braces, in the form of a St. Andrew's cross. In Belgium, iron frames are used for passenger cars, and in case of collision prove stronger and safer than those of wood. [Abr. from *Le Moniteur Industriel Belge.*]

A "Steam Hand Car" has been made for the Memphis & Paducah R. R. by M. M. Buck & Co., St. Louis, who have orders for 7 or 8 for Eastern roads. It carries 6 persons; the platform or body is *below* the axles; it is supposed capable of running 25 miles per hour. [Abr. from *St. Louis Republican.*]

The Detroit River Tunnel, proposed by Gen. W. Sooy Smith, can, it is claimed, be built at a cost not greatly exceeding that of a first-class double-track bridge. [Abr. from *Railway Review*, xiii, 17.]

The Poughkeepsie Bridge is commenced. Its length will be about a mile; hight above mean tide, 135 ft.; depth of water under it, 60 ft.; depth from river bottom to bed-work, 60 ft. The truss will be 65 feet deep. The portion over the river will have 5 spans each of 525 ft. The spans in the eastern approach have a total length about equal to the river portions. The bridge is to be completed by January, 1879; cost, about $5,000,000; builders, American Bridge Co., Pittsburg. [Abr. from *Railway Review*, xiii, 17.]

The Proposed Pacific Cable.—An effort is now making to secure the laying of an ocean cable from the western coast of this continent to Asia. A bill favoring such an enterprise passed the United States Senate a short time ago, but has been recalled from the House for further consideration. It is stated that under present arrangements a message from the Pacific States to China, Japan or Australia has to travel twenty-five thousand miles to reach its destination, with corresponding cost, while, if the proposed cable be laid, the distance will be reduced to six thousand miles and the cost of communication reduced at least sixty per cent., an item of considerable consequence to business men. The foreign trade of the seaports of China and Japan now amounts to over two thousand millions of dollars, while that of Australia is heavy and rapidly increasing. The exhibits of these countries at the Centennial have opened the eyes of Americans to the character of their trade and the desirability of turning as much of the stream as possible in this direction.

New Torpedo Carriage.—A new description of iron crrriage is being manufactured in the Royal Carriage Department, Woolwich. It is for the purpose of utilizing the discovery recently made that the fish torpedo can be discharged into the water from a ship's deck as successfully as it has hitherto been dispatched from a tube in the ship's bows under the water-line. The carriage has a tubular frame to hold the torpedo, which is projected from it through either of the port-holes by hydraulic pressure, and has its air-engine set in motion by a simple plan. The buoyancy of the torpedo having been previously regulated, it is found by experiment never to fail in rising after its dive, and going straight ahead to the object aimed at.—*Scientific American.*

A Good Ventilating Apparatus is made by filling the ordinary inlet air-pipes with a water-box, or tray, and deflecting plates, covered with any material which, by capillary attraction, may be kept always moist by disinfecting fluid of some kind, so as to purify and filter the air. [Abr. from *Am. Builder*, xii, 151.]

MINING, METALLURGY AND MINERALOGY.

Experiments on American Coals.—The National Academy of Science has prepared a memorial to Congress, asking for a continuation of Prof. W. R. Johnston's extremely valuable experiments on American coals (made some twenty-five or thirty years ago); the intention of the memorialists being to have the investigation extended to the coals of the Mississippi, and those of the country beyond, to the Pacific coast. The principle plea of this memorial is in behalf of the national protection and the demands of the U. S. Army and Navy; but the secondary one, in the interest of manufactures and commerce, would present a much stronger claim upon the government. Fuel is the primary necessity of modern civilization—the basis of modern industry, and the development of the resources of the country by investigation, under national direction and authority, is an unquestionable duty of Congress. No one of the numerous statistical publications, ever made by the authority of the United States, has had a larger quotation, or been more practically useful in the arts and sciences than this report of Prof. Johnson, and an equally thorough document embracing the fuel and full resources of this country would be appreciated in all lands. [*Jour. Frank. Inst.* lxxii, 16.]

Pennsylvania Coal Supply.—Mr. Andrew Roy estimates the available coal of the Allegheny coal-field at 743,424,000,000 tons—an amount nearly ten times greater than the estimates made by Edward Hall and Warrington Smith of the coal resources of the British Isles. The same writer states the aggregate thickness of workable coal in the Anthracite regions of Pennsylvania as 200 ft., in 2175 ft. of coal measures. In the bituminous regions of this State, near Pittsburg, he estimates 60 or 70 feet of workable coal to 2000 feet of coal measures. In West Virginia, where the Kanawha River cuts the coal measures to their base, 78 feet thickness of coal in 16 seams is revealed, and along the Ohio, from Bellaire to Pomeroy, the proportion is 40 or 50 feet of coal in 1200 to 1400 feet of rock. The number of workable seams and consequent thickness of coal in every division of the coal area are in proportion to the thickness of the carboniferous rocks. Beginning at the base of the coal measures and reaching up to the height of 400 feet, to the base of the barren measures, there exists in the bituminous regions, 3 feet of coal for every 50 feet of strata. The next 400 are generally barren of workable coal; but from the Pittsburg seam, which is the lowest bed of the upper series, to the outcrops or top of the coal stratas, the same general estimate of 3 feet of workable coal to every 50 feet of strata will hold good. [*Popular Sci. Monthly*, ix, 507.]

Bergen Hill Minerals.—The new tunnel of the Delaware and Lackawanna railway, through the trap rock formation of Bergen Hill, opposite New York City, is now nearly completed. Mr. Edward H. Fletcher, 124 West 54th Street, this city, obtained a quantity of specimens of zeolites and calcites, taken from pockets in the tunnel, at depths of 50 to 150 feet from the surface. They comprise apophyllite, prehnite, laumontite, natrolite, pectolite, stellite, stilbite, analcime, datholite, and fine varieties of calcites. Intergrouped with some of these, are also chabasite, heulandite, gmelinite, levyne, copper pyrites, iron pyrites, galena, and blende. [*Scientific American.*]

A New Chicago Rolling Mill.—The *Iron Age* reports that the Joseph H. Brown Iron & Steel Co's works in Chicago, are nearly ready to begin operations. The works in question, it is affirmed, will form, when completed, one of the most complete establishments in the west.

—Highly important gold and silver discoveries are represented to have been lately made in the vicinity of Arthur's Landing, on the north shore of Lake Superior.

—Mining operations at the Newburyport, Mass., silver-lead mines are reported to be at present "under a cloud," from want of capital to develop. Nickel ores are said to exist on the borders of the district, some of which assayed up to 8 per cent. of nickel and 3 per cent. of cobalt.

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Carbolic Acid Paper.—The carbolic paper which is now used in such quantities for packing fresh meats, etc., for the purpose of preserving them against deterioration by atmospheric or other influences, is made by melting five parts of stearine by gentle heat, and then stirring in thoroughly two parts of carbolic acid, after which five parts of paraffin in a melted form are added. The mass thus prepared is then to be well stirred together, until it cools, after which it is applied with a brush to the paper. [*The Laboratory*, ii, 88.]

Chemical Fertilizers on Potatoes and Grapes.—Prof. Ville finds that, with his "complete fertilizer" of nitrogenized matter, phosphate of lime, potash, and lime, the yield of wheat was more than double that with nitrogenized manure alone: the ratio being 46 to 20. With mineral manure alone the crop fell to 16; in unfertilized earth, to 11.

Applying these experiments to potatoes and grapes, the complete fertilizer shows a yield of 35,200 lbs. per 2·5 acres; without nitrogenous matter, a like area gave 25,960 lbs; without phosphate, 32,780 lbs. Without potash the yield fell to 16,590 lbs.; without lime, to 16,590; with no manure, only 7,700 lbs.

On the vine, the favorable influence of potassa was still more strongly felt.

Complete fertilizer gave per 2·5 acres, 26,400 lbs. of grapes, or 2534 gallons of juice; without nitrogen, there were 13,640 lbs.—1320 gals.; without phosphate, 16,060 lbs.—1531 gals.; without lime, 17,160 lbs.—1636 gals.; without any manure, *no crop.* Mr. Ville claims for potash the dominance in the potato; and that it preserves vegetables from fungi, etc.

Bunge's Chemical Balance.—One of the principal features of this balance is its short beam, which is of the form of a right-angled triangle. The portions which represent the sides of the triangle act as trusses to the main portion of the beam, which represents the triangle's base; this construction, together with the tough material employed for the trusses—namely, aluminium bronze, combines great rigidity with the least possible weight; it is capable of carrying a heavy load without appreciable flexure. The knife edges and bearings are of rock crystal. The edges touch the planes on a very long line, by which means great durability is obtained, and an adjustment is provided which precludes any deviation from perfect parallelism of the knife edges, and which is a means of obtaining maximum sensitiveness. For weighing by means of riders, a divided scale, attached to the beam, is projected in front so as to be easily seen, and to permit of the placing of riders on any division of the divided scale by means of one sliding arm, which works from the right-hand side, and takes the whole range of the beam from one end to the other; this arm lift soff the arms vertically, and its action is facilitated by a counterpoise, which carries it out of the way of the beam when it is let go. The mechanism for putting the beam in and out of action is efficient: By turning a crank-handle (on the left of the base) with a forward movement, the supports under the pans are lowered, and by limited reversal of the movement of the handle, the pans can be quieted without otherwise interfering with the balance; on turning the crank further forward, in continuance of the initial movement, a bearing, on which the pans hang when out of action, is lowered, and in its descent places the pan-suspensions upon the terminal knife edges of the beam; a still further movement of the crank puts the balance in complete action by raising the central axial bearing. [*Scientific American.*]

On the Transparency of Flames and of the Atmosphere, and on the Visibility of Flash-light Beacons. By M. Allard—The author presents several memoirs relative to experimental and theoretical researches on the above. The flames most generally employed in lighthouses are those derived from oil lamps, having many burners, with concentric wicks. M. Allard finds that the luminous intensities of these flames augment a little more rapidly than does the consumption of oil, and on comparing said intensities with the dimensions of the flames, that the former augment equally with the apparent surface, while they diminish per cubic centimetre (·06 cubic inch) in proportion as the total volume of the flame becomes greater. These results can only be explained by a defect of transparency of the flames. Different experiments lead to the adoption of the number 0·80 as the average value of the coefficient of transparency of the flames, referred to the thickness of one centimetre of flame traversed by the luminous rays. From several observations, the author has also determined that there is a state of transparency at which a light ceases to be seen from a given point. In the case of flash-lights, it is demonstrated that in the persistence of the luminous impressions on the retina, the law of decrease of the sensation is represented by an exponential function. The retina then acts like phosphorescent bodies of short period, when they are previously excited by light, and which become rapidly extinguished in darkness, since the law of extinction is the same. [*Scientific American.*]

Longitude by Telegraph.—The *Philosophical Magazine* has an article on the determination of the longitude of Cairo, from Greenwich, by the exchange of telegraph signals, by Captain C. Orde Brown. The actual experiments were between Porthcurnow and Alexandria, the whole series of cables being joined direct. The total length of cable was 3,222 nautical miles; 40 Menotti cells were used, although signals were read with 12 cells. The mean loss of time before the signal or make of circuit was visible was 134 seconds, and that before break of current signal was 1·28 seconds, the mean being 1·31 seconds.

Lightning Conductors—At one of the recent scientific conferences at South Kensington, Dr. R. J. Mann gave an account of lightning conductors, laying particular stress upon the necessity of providing a sufficient outflow for the lightning channel. He gave the arithmetical proportions which must be observed between the height of the conductor, its circumference, and the outflow; and mentioned that coke saturated with water was the best material in which to imbed the base of the conductor for the purpose of establishing sufficient earth contact. It is not necessary, he said, in answer to a queston, to insulate the conductor if the proper proportions are observed. He described Sir William Snow Harris's model which is exhibited in the collection, and showed how that distinguished man, by connecting the conductors fitted to the masts with the copper sheathing of ships, established sufficient contact with the salt sea-water. Water itself, he remarked, is not an effective receptacle for electricity, but every impurity in water greatly increases its use for the purpose. [*Scientific American.*]

The Radiometer of Dr. Crookes is employed, according to *Les Mondes*, in photography to judge of the time necessary for the exposure of an object.

—Dr. I. Walz affirms that the oxalic acid of commerce is occasionally adulterated with sulphate of magnesia (Epsom salts). He has examined a specimen which contained 22 per cent. of this impurity.

—Dr. Reimann calls attention to the fact that colored yarns, especially those dyed with magenta and other coal-tar colors, are often found discolored or even bleached. This, he explains, is due to their being wrapped in white paper containing an excess of chlorine. It would be preferable to wrap them in colored papers.

British Patent Drawings.—"The British Commissioner of Patents having decided that the drawings accompanying the provisional, complete, and final specifications of 1876 and subsequent years shall be copied by the process of photo-lithography; the regulations prescribing the mode in which the extra copy of such drawings shall be prepared must be strictly observed, in order that correct copies may be made. All specifications and drawings filed in pursuance of letters patent should be left at the office of the Commissioner for at least six days before the expiration of the time for filing the same, in order that the officers may examine the extra copy of the drawing and ascertain that it has been prepared in conformity with the rules."

These rules enjoin good white, smooth, one-faced drawing paper, of the same size as the original drawing; absolutely black indian-ink lines, of same strength or color throughout; and shading must be in lines, as open as possible: section lines not too closely drawn; no color used for any purpose; letters and figures bold and distinct; border line to be one fine line only; drawing to be delivered in a perfectly flat state or rolled upon a roller. Where there is a colored original drawing, an extra colored copy must be left.

New Process for the Manufacture of Dextrin. [M. Anthon.]—At present, fecula in the separate state is exclusively employed in the preparation of dextrin, all that portion being wasted which is retained by the fibrous part of the potato or of the bran. To prevent this loss the author recommends the use of the entire potato dried and ground after being freed from its soluble principles by washing in acidulated or alkaline water. The fecula thus obtained is sprinkled with hydrofluosilicic acid (0·5 to 1 per cent. of the weight of the fecula); it is then placed in a drying-room at 38° to 44° till there is no further loss of weight; the temperature is then raised to 70° to 75° till no loss occurs, and finally to 90°. The dessiccation being thus complete, the fecula, whilst still hot, is placed in large flat sheet-iron troughs which are introduced into large stoves heated to 100° to 125°. The transformation into dextrin is known to be complete when a sample taken out, on being cooled and moistened with cold water, adheres together in little glassy globules. [*Chem. News*, xxxiii, 260.]

Characteristics of Eosine upon Stuffs. [M. R. Wagner.]—To distinguish eosine from saffranin and other coloring matters the most striking reaction is its inverse transformation by debromisation into fluorescein. Under the influence of sodium amalgam fluorescein is very readily recognized by its splendid uranium-green fluorescence of an extreme sensibility. But this reaction, indicated by M. Baeyer, requires a skilful hand. The following procedure is easy and certain. Collodion is colored by all the dyes derived from aniline, by Magdala red and alizarin; eosine, on the contrary, is immediately decolorized by collodion. To detect it upon a tissue a drop of collodion is sufficient; if the tissue is dyed with eosine or methyl-eosine a white spot is produced. [*Deutsche Industrie Zeitung.*]

Electric Bells worked by batteries often get out of order, and the batteries require constant attention. To remedy this, Messrs. Siemens have constructed a bell worked by a magneto-electric induction machine. A Siemens armature works by means of a handle between six permanent magnets, and produces a permanent current which works the bell. To ring the bell, the handle has simply to be turned. The machine can be fixed against the wall, and occupies very little space. [*Moniteur Industriel Belge.*]

MISCELLANEOUS.

The Campagna and the Tiber.—A correspondent writes:—The subject of the improvement of the Roman Campagna is receiving serious attention from the Senate and House of Deputies at the same time with that of the improvement of the Tiber. The Italian Government, soon after it entered Rome, appointed two commissions to study the questions of the desert condition of the Campagna and the inundations of the Tiber, both of which were detrimental to the prosperity of the capital of the nation. The commissions made their reports, but in the multiplicity of other subjects they were forgotten until Garibaldi interested himself in both of them, but especially in the improvement of the Tiber. The nation can well accomplish what the city alone could not do, and with the new era which began in 1870, with the general activity of a new government and private enterprise, Rome hopes to obtain what has long been only a vain desire.

The Campagna is a territory containing about 510,878 acres which surrounds the city of Rome, and extends even to the sea. The springs and brooks not being conducted in proper channels, form marshes and ponds which render the air miasmatic. The country is therefore almost depopulated; agriculture is neglected, and there are few roads. About 15,000 acres which lie below the level of the sea can only be drained by artificial means, and the tract is now full of ponds and marshes. It is proposed to remedy this, and restore the land to cultivation, by offering premiums to private individuals who will purchase the land in small tracts from the Government. The immense profit from the produce of the soil would itself reward the labor of the cultivator.

In other parts of the Campagna the waters wander here and there or course under the ground in hidden streams, without irrigating the land to the best advantage. These should be conducted into artificial canals, made at the common expense of the government and the province, which should also concur in making roads over the country where none already exist.

In the midst of the Campagna and on its borders there are extensive tracts of land which are entirely healthy, such as Rome, the Alban Hills, and those of Tusculum, Monte Rotunda, and Porto d'Anzio. Beginning from these, and gradually extending cultivation in zones into the less salubrious country, it is hoped to unite and redeem the whole. Schools for the peasantry will opened at various points, exhibitions held of the various products of the soil and the machinery best adapted to its cultivation, and premiums will be given to the most successful farmers. The planting of trees is considered one of the chief remedies for bad air. Ostia, which is now so unhealthy that it is safe to remain there only during the month of May, was the favorite country residence of the ancient Romans, and the reason of the change was supposed to be that it was then planted with thick forests of trees, while now it is almost destitute of them. The Campagna itself was certainly inhabited in ancient times, and a practised eye can still detect the remains of several cities scattered over the plain which is now an uninhabited desert. The woods were then sacred abodes of the divinities, and their careful preservation no doubt contributed to the healthfulness of the region.

The construction of roads to connect the various points on the Campagna would greatly reduce the cost of living in this city, where all vegetables are sold at high prices. Before the improvements were made on the Esquiline and other hills they were occupied by gardens which supplied the city with fresh vegetables at low prices, but now they are brought from a distance, and even from Naples.

The subject of the Tiber, which seems to have been laid aside, has been reviewed by the various authorities, and there is now almost a certainty that the great work will be begun within a short time. Both the City Council and the Council of the Province have passed resolutions appropriating large sums to the labors necessary to improve the bed of the river within the city limits. The subject is now before the House of Deputies, and will no doubt be also favorably acted upon there. The change of Ministry and the many vacations which Parliament allows itself, have deferred the subject, but the Minister of Public Works now presents a project which is almost identical with that agreed upon by the city and the province. The Government will contribute to the expense of the work to the amount of $2,000,000. These labors are to be called the "first series of public works for the systemization of the Tiber," and will consist in the removal of ruins from the bed of the river, in regulating and clearing the shores and collecting the waste water of the city on the left bank. Afterwards it is probable that the river will be rectified, as it is called, below St. Paul's Church. That is, where its course is unnsually tortuous, cuts will be made to unite

and straighten the bed of the river and increase the force of the current, thus in some measure relieving the city in case of inundations. The great diversity of opinion among engineers as to the best means to be adopted for the prevention of inundations has been one cause of the tardy execution of the law. It is hoped that with these works the historic river will cease to be a source of alarm to the inhabitants and of injury to the city.

The Paris Exhibition of 1878.—The explanatory statement prefixed by M. Tesserene De Bort, Minister of Commerce, to the bill authorizing a Universal Exhibition in 1878, gives an idea of what the Exhibition may be if the state of Europe allows. all nations to send samples of their industry and efforts, and even amid existing complications it deserves attention. The commission proposes that the Exhibition should be opened on the 1st of May, 1878. Attaching importance to the erection of the structure in the interior of the city, because it was within its walls that so many trials were endured during the war, it has decided on recommending the Champ de Mars for its site. As respects its dimensions, after considering those of Vienna and Philadelphia, it is in favor of an area of 240,000 square metres, to be arranged like a chess-board, with the products of every nation disposed longitudinally, so that the visitors proceeding transversely can find in the same line all the products of the same kind belonging to different nationalities. The fine arts section being in the centre, will be separated from the rest of the building by large, open spaces, which will isolate it from the dust and noise. On the Trocadero, and forming part of the exhibition, is to be a large central hall at the culminating point of the plateau, which will be able to contain six thousand or eight thousand seats, to be devoted to concerts, the hearing of large instruments, public meetings and solemnities connected with the exhibition. This building will be built according to the most approved acoustic arrangements, and will be permanent. In the garden will be conservatories, an aquarium, cafés and a variety of picturesque workshops. The total expense is estimated at 35,313,000 francs, 22,228,000 francs of which are for the erection and 3,265,000 francs for the park and cascade. In 1867 23,000,000 francs were expended, the increase of expenditure expected in 1878 being due to the additional surface to be covered. The receipts reckoned upon are, for the coming occasions, 14,000,000 as against the 10,765,000 francs taken in 1867. The Palace on the Trocadero will be sold, and will also add to the receipts. In all, including the sale of material, the total receipts will be probably 19,235,000 francs, so that the deficit will be about 16,000,000. But judging from the stimulus to commerce from the Exhibition of 1867, there is much reason to believe that the State will equally benefit from that of 1878. The report of the Minister of Commerce annexed to the bill terminates as follows: "In announcing to the world a new international exhibition, France affirms her confidence in the institutions she has founded for herself. She declares her wish to persevere in the ideas of moderation and wisdom which have inspired her policy for the last five years. She proclaims that she is seeking peace, which above all has the power of rendering human activity fruitful, giving it security. We are confident that her appeal will find a sympathetic welcome everywhere and that the year 1878 will form a glorious page for civilization and our country in the annals of industrial fetes." [*Paris Corresp. London Times.*]

The Kentucky Shower of Flesh.—A writer in the *Sanitarian* takes ground that the so-called shower of flesh in Kentucky was merely the rapid development of a species of *Nostoc*, of which the dried spores had been carried about by the wind and scattered over a wide extent of the country. The specimens were submitted to Prof. J. Lawrence Smith, of Louisville, Ky., who is not only a chemist, but an able microscopist, and were pronounced to be frog spawn. Subsequently, in a letter to the Louisville *Courier-Journal*, he accepts the theory that the substance is flesh, from the fact that his examination shows the presence of muscular, cartilaginous, gelatinous and fatty matter.

Mr. A. T. Parker, of Lexington, and Dr. Kastenbine, of Louisville, examined several specimens, and were satisfied that some of them contained muscular fibre. Professor Robert Peter, of Lexington, thinks that the fall of flesh was simply the result of a kind of *post prandial* disgorging by a flock of buzzards who had been feasting themselves more abundantly than wisely on the carcass of a sheep. It is said that it is not uncommon for buzzards thus to disgorge their overcharged stomachs, and that when in a flock one commences this relief operation, the others are excited to nausea, and a general shower of half-digested meat takes place. [*Laboratory*, 86.]

A Huge Refrigerator at Brussels, can contain 50,000 pounds of meat; there is room for 1,000,000 tons of ice. It covers 18,000 square feet, and contains nine compartments of 30,000 cubic feet each. The walls are double, and filled with moss and sawdust. [*Am. Builder*, xii, 169.]

The Transplantation and Implantation of Hairs.—An interesting paper on this subject appears in the *Zeitschrift für Biologie*, from the pen of Dr. Ernst Schweninger, of Munich. He gives the following as the results of his numerous experiments: First, that hairs that have been recently extracted, and to the root of which cell-layers of the root-sheath still remain adherent, if brought in contact with freshly-granulating surface, are capable of contracting adhesions with this, and that from this point a process of skinning over may commence, as after cutaneous transplantation. He has further shown that such hair root-sheaths can attach themselves to the iris and continue to grow. The iris, therefore, constitutes an excellent place for conducting experimental researches of this nature. [*Lancet.*]

—A commission of Engineers is at present engaged in preparing plans for an underground railway in Paris, to connect several of the prominent points in the city.

—The *Commission de Geographie Commerciale* has appointed a committee of initiative with the object of forming an international society for a final and complete exploration of the Isthmus of Panama, to determine the best course of the canal. M. de Lesseps is nominated as president,

Equalization of Light in Hospitals and Rooms.—A writer in *The Engineer*, (xlii, 7) calls for a mode of equalizing light in ophthalmic hospitals; and proposes a system by which a thermopile takes cognizance of, and regulates automatically, the rays entering such rooms.

IMPORTANT PAPERS, too long to reproduce in our columns.

THE MANUFACTURE OF STEEL AND MODE OF WORKING IT. Chernoff. Translated by Anderson. 7 cuts. *The Engineer.* xlii, 1.

VARIATIONS IN THE VELOCITY OF CRANK SHAFTS. (Illust.) *Engineering*, xxii, 1.

AMERICAN IRON BRIDGES. Read before the American Institute of Mining Engineers. By Thos. C. Clarke [of Clarke, Reeves & Co.] *E. & M. Jour.*, xxii, 3.

ON THE HOR BLAST, with an explanation of its mode of action in Iron Furnaces of different capacities. Read before the Am. Inst. Mining Engineers. By I. Lowthian Bell, M.P., F.R.S. In *E. M. Jour.* xxii, 6.

THE FULLERTON AVENUE CONDUIT. By Lyman E. Cooley, C. E. In *Engineering News*, iii, Nos. 27 and 28.

CONTRACTOR'S PLANT. By Alexander Clark. Read before the Edinburgh and Leith Engineer's Society. *Engineering News*, iii, Nos. 27 and 28.

EDITORIAL CORRESPONDENCE.

EDITORS OF THE POLYTECHNIC REVIEW: Practical mechanics who have had a life-long experience in any trade ought to know the wants of their art, and be able to suggest improvements in methods of production. The conscience of science will go further, and agree that, on opportunity, every worthy mechanic is bound to correct the faults which his experience proves to exist in the rules and methods of his art. This is more especially true and imperative in a trade like ship-building, where the saving of large amounts of property and numbers of human lives depends upon the perfecting of processes and appliances in conjunction with the choice of good and suitable materials. Accordingly, to improve the system of building and repairing vessels on the Lakes, to the end that there might be increased safety to the lives and property committed to their protection, was a work that ship-builders had only to be called to participate in, to render the duty a labor of love.

Capt. E. P. Dorr honored the profession of a mariner when he committed the responsibility of framing a system of rules for ship-building to a council of practical shipwrights. Identified with the inspection and classification of vessels for more than thirty years, and an acknowledged authority on characterization with the underwriters of the Lakes, his experience taught him there was safety in counsel. The shipbuilders, invited to produce the new rules, with but one or two exceptions, were shipowners also, and several of them among the largest on the Lakes, so that the shipping interest was fairly represented. The presence of an iron ship-builder was also secured, that no interest should be unheard.

In the discussions of the Counsel the defects of all classes of vessels were pointed out, to mark and remedy imperfections being the special business in hand. It was the wish of Capt. Dorr to elevate the standard of Lake ship-building to a par with the highest known in the vessel trade of the world, not only for the advantage of inland navigation, but that our Lake vessels might meet the coming wants and changes of trade consequent upon the completion of the new Canadian canals, which will permit the largest Lake vessels to take part in the *ocean* trade. It is a matter of history that since underwriters have classified vessels by well-considered rules, and accorded characters on the grounds of merit, the raising of the standard for construction has always been beneficial to the interest concerned. Whatever tends to reduce ths losses at sea of any class or description of vessel, works to the advantage of that class, and nothing is more detrimental to any description of vessel than to fall below the others in safety and reliability.

In some respects Lake shipping has peculiar requirements, the chief of these being light draft of water and great strength of bottom. Every vessel is liable to ground or strike the bottom in the course of each voyage she makes, either in port or outside; and every vessel, without exception, to be seaworthy, must be able to strike a bar, if not a reef, without danger of rupturing her skin or springing a leak at the least touch or collision. In framing the new rules, especial attention was given to this liability to striking bottom, to the end that cargoes, vessels, and precious lives might be reasonably safe under the test of common and certain exposures. To a certainty, the best and cheapest device for defending the bottom of a vessel from the effects of blows and collisions is to give them solid bottoms of wood. The utility of thus constructing the bottoms of large vessels having been repeatedly demonstrated to the satisfaction of competent judges, the new system of construction bas retained the old rule, and its principle has received such extension in its application as experience fully warrants. Iron vessels must have solid wooden bottoms, the same as wooden vessels, to be equally safe and rate first class.

Following up the idea of increased strength of safety, the new rules provide for the building of vessels of wood with frames of long timbers, bent to shape by machinery, the futtocks springing from keel to rail in single sticks, and the floors in whole length across the bottom. The framing of vessels by this method is undoubtedly the most important invention introduced in modern shipbuilding. Where vessels are so liable to take the bottom, go ashore and be got off, as they are in the navigation of the Lakes, this sterling system of framing ought to be generally adopted. The oak timber of the Lake region is signally adapted to the machine-bending of frames and knees for ships, and by the process of manufacture will be made singularly durable.

With regard to the rules for scantlings of timbers, a system of proportioning all the timbers of a vessel, according to the requirements of each for strength, has been adopted, instead of giving tables founded on tonnage, having nothing but their arbitrary character to commend their use. A builder working by these rules will acquire a knowledge of proportions, and a practice of applying principles which must incline him to be a thinking mechanic rather than a mere machine. Upon all the rules formerly in use great improvement has been made; while it has been said that the proportioning of frames, keelsons, centre-boards and boxes, clamps, shelves, beams, planking, arches and iron strapping, by rules which are original, is a contribution to the science of ship-building.

But, perhaps the highest utility will be accorded to the rule for free-board and load-line, the determination of which, though belonging to the ship-builder, has been generally omitted in treatises on marine architecture, and is now for the first time broadly grounded on mechanical principles, and experience in loading vessels. A general rule for free-board for the average vessel is indispensable in a system of construc tion and characterization. The structure must be planned for the load, hence the sizes of the various parts composing a ship of certain dimensions should be based, primarily, on the load the vessel is to carry; and, secondarily, upon the displacement and wave buoyancy necessary to safe flotation at sea, and so involves a knowledge of the proper location of the load-line. Without a rule for fixing the load-line, there can be no perfect design of a ship, nor a scheme of proportions for building worthy of the guidance of a mechanic. Indeed, the deep load draft must form the first step in the design—the ship's body being simply projected below and above this line. Accordingly, the new rules are intended to govern the construction of vessels with reference to their carrying, in safety, the burdens which they may bear at the designated free-board line.

One result of the application of the new rule for free-board is to teach that there is an economic, as there is a safety limit to the draft of water of large ships. The free-board is shown to depend upon the form and dimensions of vessels, the depth having the most influence. The operation of the rule will tend to the adoption of safe proportions and approved models of vessels, and discourage the building of architectural monstrosities.

The system of characterization adopted by Capt. Dorr was framed by the writer with a special view to encourage and ensure the construction of well-designed, strongly-built, and long-enduring vessels. The day has gone by for wasting money either in repairing or building poor vessels—such as may be worn out and thrown away, or paid for by the underwriters in a few years. Strict rules and impartial surveys give value to shipping property, and protect it from depreciation by timely repairs. Builders always find their interest in

the elevated characters of new vessels, which they build at improved prices, and for broadened markets. A loose system of construction, and a low standard of characterization are injurious to trade. Hitherto Lake vessels have had no rating in *years*. Hereafter they may have the benefit of this key to character, giving market value, sustaining price, and commanding employment through the diminished cost of insurance.

WM. W. BATES.

BIBLIOGRAPHICAL NOTICE.

THE CONSTRUCTION AND CHARACTERIZATION OF VESSELS.

Under the above title CAPT. E. P. DORR, of Buffalo, the LLOYD of the Lakes, has published the rules for an improved system of building, repairing and rating vessels engaged in Lake trade. The new rules derive their origin from a Council of shipbuilders convened at Buffalo, by Capt. Dorr, in 1874. The Secretary of the Council, who was also the Chairman of the Committee on the preparation of rules, was WM. W. BATES, of Chicago. The reader will find many developments of study and experiment in this small octavo volume of 120 pages, and some originations, we cannot doubt, of great value and utility to builders, owners and underwriters. As deserving of special mention, we cite the classification of American ship-building woods, the principle of load-line limitation and the rules for free-board. We will only add that the new system of construction and characterization, it is confidently believed, will bear comparison with any in use in any part of the world, and will be productive of great good wherever adopted, by turning off vessels stronger, safer, lighter and more capacious than ever before generally built.

CENTENNIAL NOTES.

Robert Wetherill & Co., Chester, Pa., show a well made and finished horizontal Corliss engine, 10 x 24, with plain slab bed-plate, and fitted with Wetherill's patent piston-packing. This engine is not under steam, and hence we cannot say whether it is superior to the generally excellent engines of this type made as a specialty by the same builders.

Erratum.—A very laughable misprint occurred in our Centennial Note of the N. Y. Safety Steam Power Co., July 22d. For "steam *jacket*," 51 ft. long, read steam *yacht* of that length. G.

Car Replacer.—This replacer comprises two pieces, one—a wedge-shaped inclined plane—is keyed to the outer side of the rail. The other, also an inclined plane, is grooved to guide the wheels and is keyed to the inner side of the opposite rail. These being placed in position in front of the foremost truck, it is easily hauled up the inclined faces onto the track.

U. S. patents for sale by S. S. Jamieson, Machinery Hall, B—66.

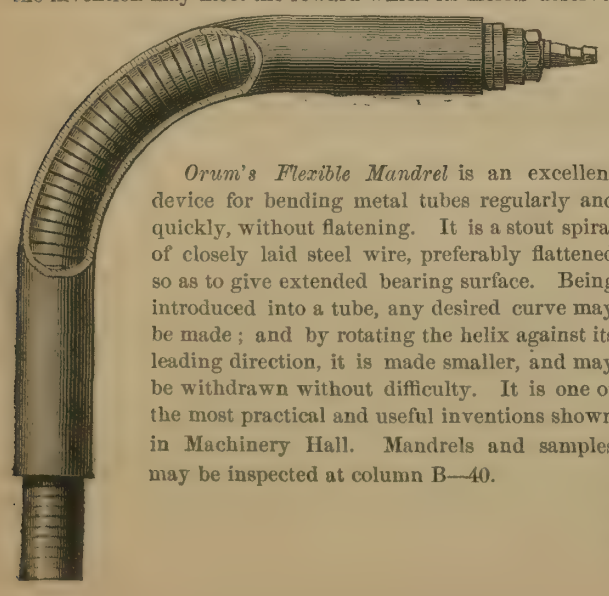
—Mr. Prouty must be considered as a public benefactor. When the the mercury is struggling among the nineties, he takes a pail of water and one of Johnson's patent force pumps with a sprinkler attached, and goes up and down the aisles of Machinery Hall, dispensing moisture and coolness to the air.

This pump, though small, has been adopted as a fire extinguisher by the War Department, Harvard College, and several towns. On exhibition at Column D–59.

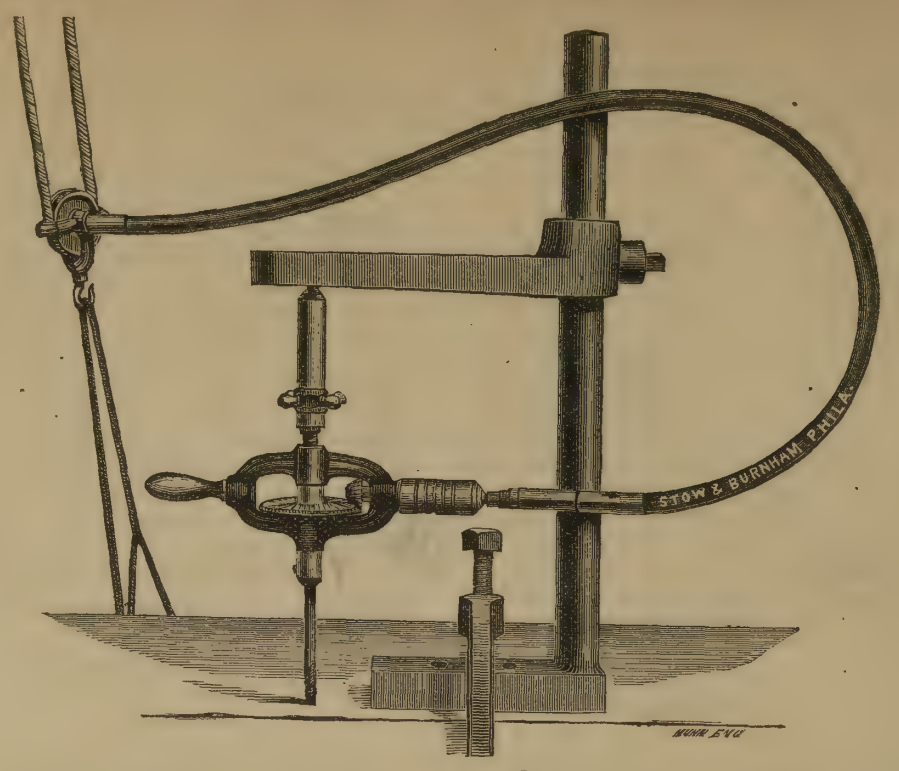
S. L. Harrison's Improved Car Wheel and Axle.—A third bearing is shrunk onto the middle of the axle. One wheel is rigged fast as usuul, the other is rigged to a sleeve, which in rounding curves works freely on the outer and middle bearings, said sleeve is held securely in place by a cap which also works freely on the middle bearing.

Railroad men pronounce it a model of simplicity and effectiveness. It obviates the jar and vibration of sliding, which is so wearing both to rolling stock and the nerves of passengers.

Old stock may be altered at a trifling expense, and we hope the invention may meet the reward which its merits deserve.



Orum's Flexible Mandrel is an excellent device for bending metal tubes regularly and quickly, without flatening. It is a stout spiral of closely laid steel wire, preferably flattened so as to give extended bearing surface. Being introduced into a tube, any desired curve may be made; and by rotating the helix against its leading direction, it is made smaller, and may be withdrawn without difficulty. It is one of the most practical and useful inventions shown in Machinery Hall. Mandrels and samples may be inspected at column B—40.



THE STOW FLEXIBLE POWER TRANSMITTOR.

Passing along the north avenue of Machinery Hall, in the neighborhood of the Westinghouse Brake, our attention was forcibly attracted to what appeared to be a section of inch leather hose, with a revolving twist-drill for a nozzle—the "hose" lying quietly upon the floor, and the drill or "nozzle" making a clean smooth hole through a chilled car-wheel, already perforated several times by the same means.

Following the "hose" backward and round a corner, it was seen to terminate in the arbor of a rapidly revolving grooved pulley, fastened temporarily to the floor, and driven by a braided round leather belt, which, after several corner-turnings, is seen to be driven by a grooved pulley high over head. The mystery was explained. The "hose" was the *sheath* of what is termed a "flexible power-transmittor"—a closely laid cable of steel wire which accommodates itself to any flexure, while transmitting, unabated, the rotation communicated to it (in the direction of its spiral) at the end.

This cable has a high *torsional*, but a low *bending*, resistance.

A very simple device; the drill may be thrown in or out of gear in an instant. This power-transmittor may be carried around, under, or over any obstacle; and by it may be applied to any angle, a twist or ratchet-drill, a tap, die, diamond drill, wood-auger, carving or polishing tool, horse clipper or brush, or any other implement requiring rotation, and rapid and easy adjustment.

Carried under a heavy casting, or into the man-hole of a boiler, or wherever boring, drilling, polishing, etc., requires, the application and guidance by hand is all that is needed.

Few more simple or convenient devices have been presented to notice; and each day new applications are presented. Cloth shearing and cutting, and the cutting of flue-tubes are readily effected by its means.

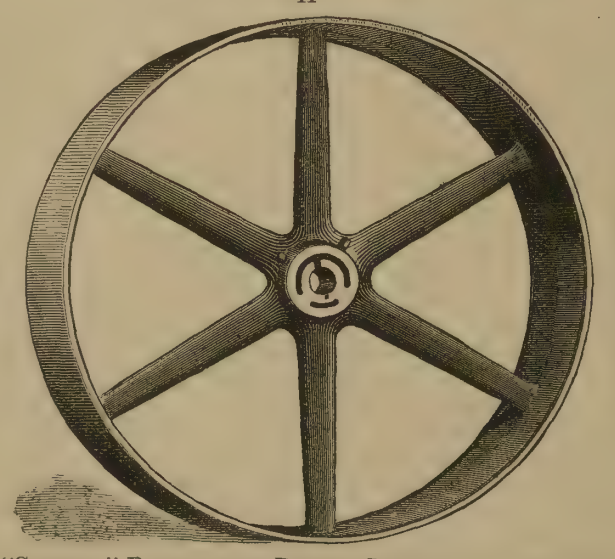
This seems to be the first successful application of such a flexible shaft, for general purposes of transmission of power, and as such it is deserving of especial recognition and notice. The patentee is Nelson Stow; the manufacturers are Messrs. Stow & Burnham, No. 500 North Fifteenth Street, Philadelphia. The exhibit may be seen in practical operation at Section 9, D. 68, Machinery Hall, Centennial Buildings.

The firm is now filling an order for Wm. Struthers, who has the contract for the New Public Buildings in this city. Several of the marble-dressing machines may be seen in operation at Mr. Struthers' marble works.

INDUSTRIAL.

COUPLINGS AND PULLEYS FOR SHAFTING.

II



"CRESSON" PULLEY WITH PATENT INTERNAL CLAMP HUB.
(*Machinery Hall, C—71 to 73*)

Having thus endeavored to show why the Internal Clamp Couplings are far superior to all other styles of shaft-couplings, it may be well to add that the *internal clamp device is no less valuable in its applications to the hubs of pulleys gears and cranks.*

This assertion will be appreciated, if we witness, for instance, the cumbersome way of fitting and erecting large pulleys or gears as it had to be done heretofore. It was customary to enlarge the shaft on those places where a large driving pulley had to be fastened. These places had to be turned with great accuracy by well skilled machinists, and when so turned, the wheel had to be forced upon the shaft by a press to insure its fitting; after this it generally had to be forced off again for convenience in shipping the machinery. Again, when being erected, the same process of forcing on the shaft had to be repeated. This was time-consuming labor, while by the repeated forcing the gripping power became materially reduced, and the cost of the machinery proportionately increased. If, on the contrary, wheels with internal clamp hubs are employed, there is then no need for leaving the shaft stronger or for making a special fit; the shaft may be turned parallel as ordinarily. By boring the wheel a little smaller than the shaft, and by opening the clamps by wedges just enough to allow the shaft to pass through the hole freely, *we may obtain a forcing fit at any desired point of the shaft*, by merely removing the wedges and tightening the set-screws. We notice further that the set-screws, only effecting a pressure upon the clamps, cannot injure the shaft, as is the case in ordinary pulleys, where screws and shafts are in direct contact.

A test made with a pulley of 3½ inches bore, and constructed as shown in the illustration, proved that a forcing fit actually will be obtained. It took a pressure of 16 tons to move the pulley on the shaft, which had been greased beforehand. And from the polishing the shaft received from friction with the hub when being forced through the latter, it was demonstrated that the pressure had been uniformly distributed around the entire surface of the shaft. Which fact is evidence of a resistance by friction powerful enough to hold the heaviest fly-wheels.

The internal clamp pulleys are considered by all first-class mechanics who have seen them a valuable invention, they are running in many mills, factories and workshops, in places best calculated to try their merits. All users give them unqualified praise, and the demand for them is rapidly increasing.

Although the internal clamps (applied to couplings and hubs), are of recent invention; yet, if we may judge by the great favor with which they have been received in all civilized countries, it shows clearly that they perfectly meet a want which has long been felt.

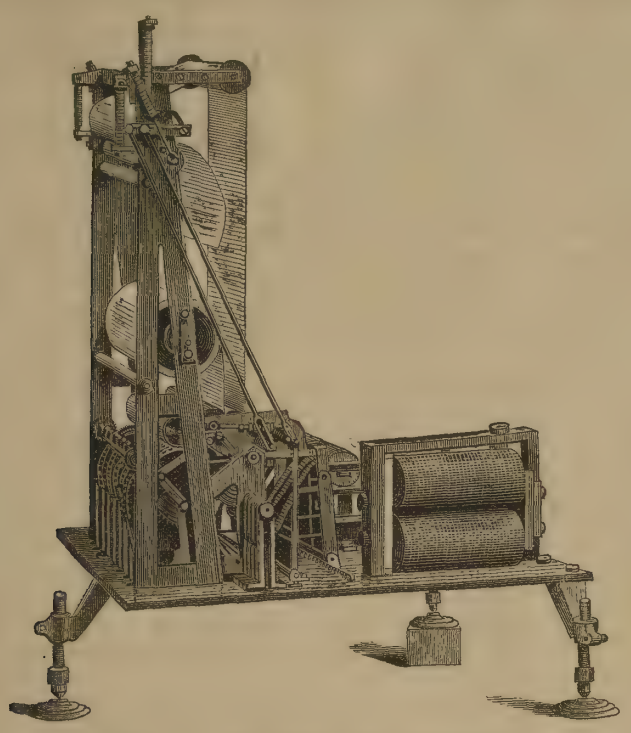
"It's a wonderful saw," was the repeated exclamation of one of the English Judges, as he witnessed one of Boynton's buck saws cut through an inch board five inches wide with a single stroke down and up. And his admiration was very great as he watched two men saw through a gum log upwards of eleven inches in diameter in less than seven seconds by hand, with one of the "Lightning saws." C. K. H.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, AUGUST 5, 1876. NO. 5.



THEORELL'S PRINTING METEOROGRAPH.

This beautifully designed and constructed recording apparatus is in constant operation at the Swedish School House, Centennial Exhibition. The thermometers, barometers, anemometer, etc., are in a specially constructed building near the school-house, in a location not well adapted for accurate registry of wind force and direction. Due credit should be given Mr. Sörensen for the exquisite workmanship of the apparatus, which was set up by himself.

The following description is that prepared in Stockholm for the constructor.

"Meteorological observations are shown by this instrument on tables printed on a slip of paper. Of the six tabular columns, the first gives the hours; the second, the velocity of the wind; the third, the direction of the same; the fourth, the temperature; the fifth, the degree of humidity, according to August's method; and the sixth, the atmospheric pressure, which is given in millimetres. The degrees of the thermometer employed are those of the centigrade scale, and negative degrees are expressed by their complements of 100. The direction of the wind is indicated by figures from 1 to 32. The numbers expressing the velocity of the wind signify metres in a second.

"The registration takes place by means of electrical currents, which are closed in the barometer and both the thermometers by contact between the quicksilver and steel wires that descend into their tubes, and at the weather-cock and anemometer by contact between a metal knob, which is put into motion by the current, and a wheel, which is in a direct mechanic combination with each of these instruments.

"The steel wires in the barometer and in both the thermometers are connected, each by its respective system of brass wheels, with numerical types engraved on the edges, in such a manner that the rotation of the wheels causes an upward or downward motion of the steel wires, so that the point of the scale on which the lower extremity of the wire is situated, is necessarily that indicated by the number appearing at the same moment uppermost on the corresponding wheels. The two other brass wheels with engraved figures are likewise combined, by means of electric currents, with the above-named metal knobs in the weather-cock and the anemometer, in such a manner that the figure which is uppermost on the periphery of the wheels at the moment it is about to be registered, indicates the direction of the wind at the same moment and its mean force during the preceding quarter of an hour.

"The wheels containing the figures are governed by an electro-magnetic motor, which for each observation sets the five systems successively in motion until the corresponding wires have reached the quicksilver in the barometer and the two thermometers, and caused a contact between the above-named metal knob in the weather-cock and the anemometer, and the wheels, which are in a mechanical combination with each of these instruments.

"The numbers, therefore, that are uppermost on the numbered wheels, are just those which indicate the height of the barometer, and of the two thermometers, as well as the direction and velocity of the wind. And, now, the same electro-magnetic motor operates upon a printing apparatus, which, after having deposited color on the types, presses the above-mentioned slip of paper against them.

"This being done, the steel wires are drawn up again by the motor, which stops as soon as a certain distance from the quicksilver is attained, and all is ready for the next observation.

"The interval between the observations is a quarter of an hour.

"In order to facilitate the appreciation of the results obtained by the above described construction, we take the liberty of directing attention to the following considerations:

"The instrument, as we perceive, gives the observations in such a form that they may be immediately, and without further modification, used by the meteorologist in his work.

"A large number of comparisons very carefully made, have shown that the observations registered with the aid of the method here employed have an accuracy equal to that usually attainable by ocular observation.

"The zinc vessel, in which the upper ends of the thermometers are enclosed, is so air-tight that it has been found possible, by means of chloride of lime and caustic potash, to keep the enclosed air always free from damp and carbonic acid, a precaution which, it will be easily understood, is necessary in every clime where the temperature is liable to sink below the freezing point, but is still more so in order to protect both the quicksilver and the steel wires from oxydation, and thus preserve the galvanic contact. A meteorograph of this construction has now been used at Upsala Observatory for two years, and during that time it has made four observations every hour without causing any perceptible change in the surface either of the quicksilver or the steel wires, that could in any way affect either the free efficiency of the instrument or its degree of accuracy, which, throughout the whole time, has been found to be as above stated.

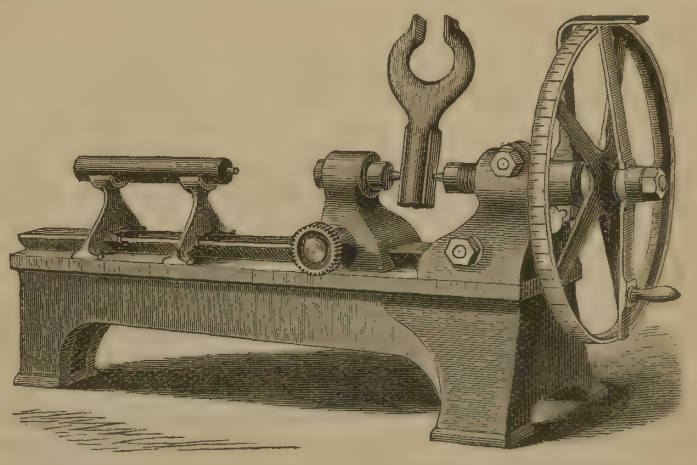
"As the clock, which determines the time of the observations, does not require winding up, the instrument itself restoring the tension of the mainspring every quarter of an hour, it continues going as long as the impellent force, *i. e.* the electric current, is maintained; and as the slip of paper applied lasts for fully three months, it is clear that that is the period for which the instrument may be left to itself. The work then requisite is little more than taking out, cutting, and sewing up, in order, the paper of observations, and replacing it by another slip. Thus we see that this instrument requires but very little time and labor from the person who takes charge of it.

"A printing meteorograph, differing from this only so far that the latter has been improved and perfected in several details, has been constructed by the same mechanician, Mr. Sörensen, for the Imperial Central Establishment for meteorology in Vienna, where it has been in daily use since September, 1874; and during that time it has given exact and true observations. A description of this Meteorograph is inserted in "Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, redigirt von C. Jelinek und J. Hann." Volume X, Nos. 16 and 17.

Finally it may be remarked, that the principle on which this instrument has been constructed may be adopted with the same advantage for observing the particulars of any other phenomenon, provided they can be indicated by an index which produces a galvanic contact." G.

THE CORNELL MEASURING MACHINE.

In our issue of July 22, page 16, we illustrated the Amateur Foot Lathe, exhibited by the Department of Mechanical Engineering of Cornell University, at B-68, Machinery Hall. We herewith describe the measuring machine forming part of the same exhibit, and which is also the work of the students of this institution.



The Measuring Machine shown in the accompanying engraving, though useful for other purposes, was specially designed for the manufacture of standard gauges, and measures from 0° to 12″ by 1-10,000th of an inch, which is as fine as it is practicable to work in ordinary machine shop use. The machine, although resembling a lathe, is only about 18 inches in length, and has the three legs cast with the bed and is made to set upon a table or bench. The measuring screw has 16 threads to the inch, and the graduated wheel is divided into 625 equal parts, so that the movement of the wheel, one of those divisions, changes the distance between the measuring points of feelers the 1-10,000th of an inch.

The screw has a travel of a little more than one inch and the length of the thread on the screw and the thread in the nut are equal, so that the wear will remain equal. The handle for turning the wheel is not fixed in the wheel itself, but to a friction bar, which by the central nut is set so as to give friction enough to just turn the screw, yet

not so much but that it will slip when the two measuring points or feelers come in contact.

The arm or index from which the reading of the machine is made is not fixed firmly to the body of the machine, but is threaded upon the projecting boss and is movable back and forth, so that in adjusting the machine it is not necessary to set the back feeler with great accuracy; for when it is set nearly correct and the two feelers brought in contact, the index can be turned back or forwards until it coincides with the zero mark on the wheel.

It was the aim to make the screw 16 threads to the inch, and if it had been perfect then, the index from which the reading is taken should exactly coincide with the axis of the screw; but the finished screw proved to vary about one in five thousand, and by cutting the index to the proper angle this imperfection was corrected to the greatest accuracy.

To use the machine for measuring pieces longer than one inch, and less than two inches, the foot-stock is set back about one inch, a standard inch piece is set between the two feelers, and the handle turned until the friction bar again slips; the index is then moved until it coincides with the zero mark; and so by using a set of standards varying by inches from one to eleven, all sizes up to a foot can be measured, and the machine is always adjusted at the time of taking the measurement.

THE MECHANICAL ACTION OF LIGHT.

A Lecture delivered at the Royal Institution, London.

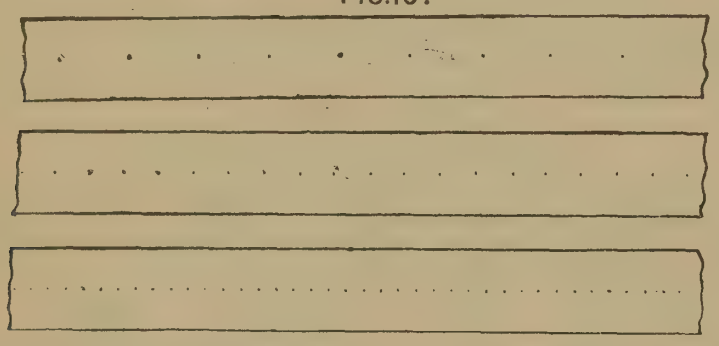
BY W. CROOKES, F. R. S.

V.

Here the inner magnet is too strong to allow the radiometer to start with a faint light without some initial impetus. Imagine the instrument to be on the top of a mountain away from everybody, and I wish to start it in the morning. Outside the bulb are a few coils of insulated copper wire, and by depressing the key for an instant I pass an electric current from the battery through them. The interior magnet is immediately deflected from its north-south position, and the impetus thus gained enables the light to keep up the rotation. In a proper meteorological instrument I should have an astatic combination inside the bulb, so that a very faint light would be sufficient to start it, but in this case I am obliged to set it going by an electric current. I have placed a candle near the magnetic radiometer. I now touch the key; the instrument immediately responds; the paper unwinds from the Morse instrument, and on it you will see dots in regular order. I put the candle 8 inches off, and the dots come wide apart. I place it 5¾ inches off, and two dots come where one did before. I bring the candle 4 inches from the instrument, and the dots become four times as numerous (Fig. 10), thus recording automatically the intensity of the light falling on the instrument, and proving that in this case also the radiometer obeys the law of inverse squares.

This instrument, the principle of which I have illustrated to-night, is not a mere toy or scientific curiosity, but it is capable of giving much useful information in climatology. You are well aware that the temperature, the rainfall, the atmospheric pressure, the direction and force of the wind, are now carefully studied in most

FIG. 10.



countries, in order to elucidate their sanitary condition, their animal and vegetable productions, and their agricultural capabilities. But one most important element, the amount of light received at any given place, has been hitherto but very crudely and approximately estimated, or rather guessed at. Yet it cannot be denied that sunlight has its effect upon life and health, vegetable, animal, and human, and that its relative amount at any place is hence a point of no small moment. The difficulty is now overcome by such an instrument as this. The radiometer may be permanently placed on some tall building, or high mountain, and, by connecting it by telegraphic wires to a central observatory, an exact account can be kept of the proportion of sunlight received in different latitudes, and at various heights above the sea-level. Furthermore, our records of the comparative temperature of different places have been hitherto deficient. The temperature of a country depends partly on the amount of rays which it receives direct from the sun, and partly on the atmospheric and oceanic currents, warm or cold, which sweep over or near it. The thermometer does not discriminate between these influences; but the radiometer will enable us now to distinguish how much of the annual temperature of a place is due to the direct influence of the sun alone, and how much to the other factors above referred to.

I now come to the last question which I stated at the beginning of this lecture—"What is the amount of force exerted by radiation?" Well, I can calculate out the force in a certain way, from data supplied by this torsion apparatus (Fig. 4). Knowing the weight of the beam, the power of the torsion fibre of glass, its time of oscillation, and the size of the surface acted on, it is not difficult to calculate the amount of force required to deflect the beam through a given angle; but I want to get a more direct measure of the force. I throw a ray of light upon one of these instruments, and it gives a push; surely it is possible to measure the amount of this push in parts of a grain. This I have succeeded in doing in the instrument behind me; but before showing the experiment I want to illustrate the principle upon which it depends. Here is a very fine glass fibre suspended from a horizontal bar, and I wish to show you the strength of it. The fibre is only a few thousandths of an inch thick; it is about 3 feet long, and at the lower end is hanging a scale-pan, weighing 100 grains. So I start with a pull of 100 grains on it. I now add little lead weights, 50 grains each, till it breaks. It bears a pull of 750 grains, but gives way when additional weight is added. You see then the great strength of a fibre of glass, so fine as to be invisible to all who are not close to it, to resist a tensile strain.

Now I will illustrate another equally important property of a glass thread, viz., its power to resist torsion. Here is a still finer glass thread, stretched horizontally between two supports; and in order to show its position I have put little jockeys of paper on it. One end is cemented firmly to a wooden block, and the other end is attached to a little instrument called a counter—a little machine for registering the number of revolutions. I now turn this handle till the fibre breaks, and the counter will tell me how many twists I have given this fibre of glass. You see it breaks at twenty revolutions. This is rather a thicker fibre than usual. I have had them bear more than 200 turns without breaking, and some that I have worked with are so fine that if I hold one of them by the end it curls itself up and floats about the room like a piece of spider's thread.

Having now illustrated these properties of glass fibres, I will try to show a very delicate experiment. I want to ascertain the amount of pressure which radiation exerts on a blackened surface. I will put a ray of light on the pan of a balance, and give you its weight in grains, for I think in this Institution and before this audience I may be allowed a scientific use of the imagination, and may speak of weighing that which is not affected by gravitation.

The principle of the instrument is that of W. Ritchie's torsion balance, described by him in the "Philosophical Transaction" for 1830. The construction is somewhat complicated, but it can be made out on reference to the diagram (Fig. 11). A light beam, A B, having 2 square inches of pith, C, at one end, is balanced on a very fine fibre of glass, D D′, stretched horizontally in a tube; one end of the fibre being connected with a torsion handle, E, passing through the tube, and indicating angular movements on a graduated circle. The beam is cemented to the torsion fibre, and the whole is enclosed in glass and connected with the mercury pump by a spiral tube, F, and exhausted as perfectly as possible. G is a spiral spring, to keep the fibre in a uniform state of tension. H is a piece of cocoon silk. I is a glass stopper, which is ground into the tube as perfectly as possible, and then highly polished and lubricated with melted india-rubber, which is the only substance I know that allows perfect lubrication and will still hold a vacuum. The pith, C, represents the scale-pan of the balance. The cross-beam, A B, which carries it, is cemented firmly to the thin glass fibre, D, and in the centre is a piece of mirror, K. Now the cross-beam, A B, and the fibre D being rigidly connected together, any twist which I give to the torsion handle, E, will throw the beam out of adjustment. If, on the other hand, I place a weight on the piece of pith, C, that end of the beam will fall down, and I shall have to turn the handle, E, round and round a certain number of times, until I have put sufficient torsion on the fibre D to lift up the beam. Now, according to the law of torsion, the force with which a perfectly elastic body like glass tends to untwist itself is directly proportional to the number of degrees through which it has been twisted; therefore, knowing how many degrees of torsion I must put on the fibre to lift the up $\frac{1}{100}$ of a grain weight, I can tell how many degrees of torsion are required to lift up any other weight; and conversely, putting an unknown weight or pressure on the pith, I can find its equivalent in grains by seeing how much torsion it is equal to. Thus, if $\frac{1}{100}$ of a grain requires 10,000 degrees of torsion, $\frac{1}{50}$ of a grain would require 20,000 degrees; and conversely, a weight which required 5,000 degrees torsion would weigh $\frac{1}{200}$ of a grain. Once knowing the torsion equivalent of $\frac{1}{100}$ of a grain, the ratio of the known to the unknown weights is given by the degrees of torsion.

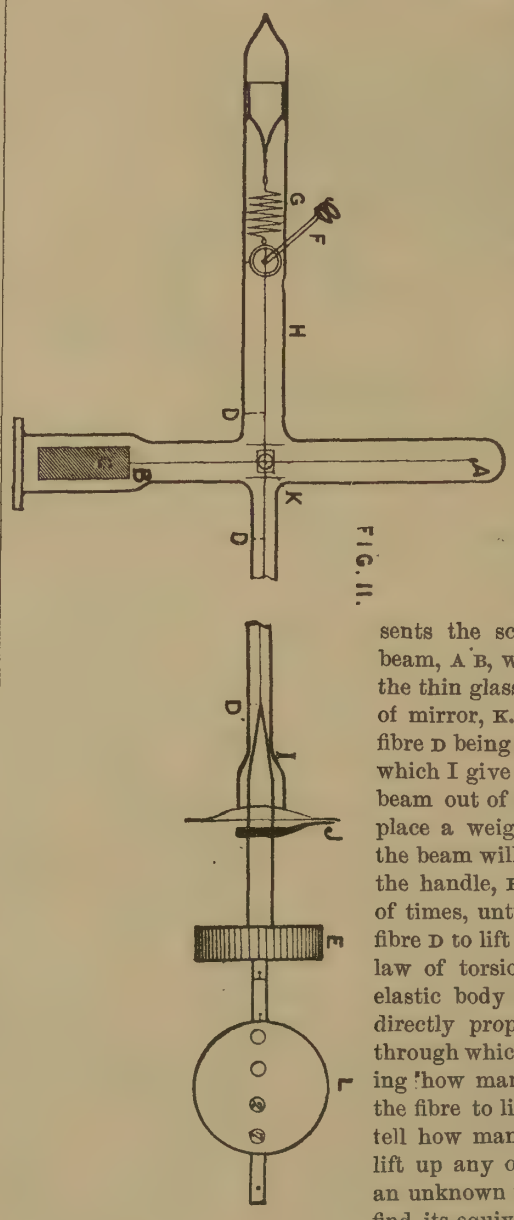


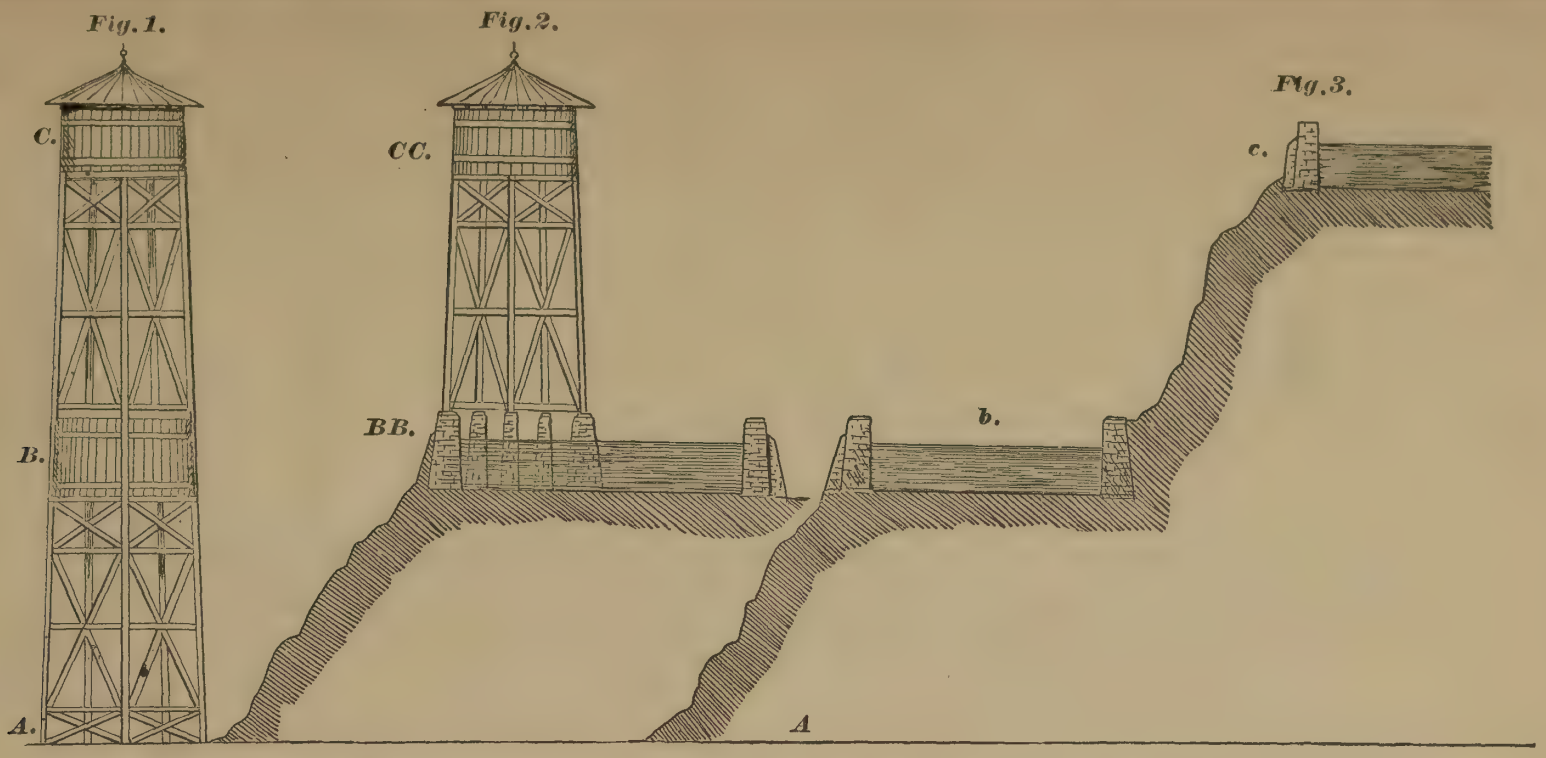
FIG. 11.

(*To be continued.*)

THANKS.

We beg to extend our thanks to those readers and friends of the POLYTECHNIC REVIEW, who are kind enough to exert their influence in extending our subscription list. We have been able to repay this kindness, first by an increase in the size of our journal, and second, by a change from a monthly to a weekly issue—without an increase in subscription rates.

If our readers will be good enough to continue their kind efforts, we promise that their enterprise will not go unrewarded.



SYSTEM OF RESERVOIRS FOR WATER WORKS.

As many of our cities and villages are constructing water works, and many others have the subject under consideration, any plan that will increase the efficiency and economy of water supply must receive the attention that its importance demands.

It is claimed for the plan represented in the illustration, that it has two important advantages, the first being the great degree of security afforded, and the second being a large saving of current expense.

The plan consists in having two reservoirs at different elevations, each so connected with the service pipes and pumps that either reservoir may at any moment be brought into service and the other shut off. The water is ordinarily pumped into the lower reservoir, which is placed at a proper elevation for domestic supply.

The upper reservoir is located at such an elevation that it will give a sufficient pressure for fire purposes. After being filled with water, it is disconnected from the service pipes and pumps, until a fire occurs, when it is again brought into connection with the service pipes and pumps.

By this means, only the water which is used during a fire is pumped into the upper reservoir. Thus there is a reservoir always full, and ready at a moment's warning to extinguish fires.

The advantages claimed for this plan are:

1. There is a supply on hand ready to extinguish fires, and not dependent on the present condition of pumps, boilers and pipes.

2. By this arrangement the engines can, if they have sufficient capacity, keep the reservoirs filled during the day, after which the fires may be banked, thus saving the expense incurred by running at night.

3. The engineer has a daily opportunity to adjust the engines and pumps while they are at rest, and is enabled to keep them in good condition.

4. In many towns and cities steam fire engines may be dispensed with.

5. Only half as much fuel would be used, as is required in the standpipe and single reservoir system; for only half the power that is necessary in the latter systems would serve to pump the water into the lower reservoir. The wear of the machinery would also be correspondingly less.

The illustrations are intended to show how this plan may be used in different localities.

Figure 1 represents a plan of reservoirs for level countries, such as the prairies of the West, where there is no natural elevation upon which to construct a reservoir, even for domestic use. *C* and *B* are two tanks, elevated on artificial supports, *C* being for fire purposes, and *B* for domestic use.

Figure 3. Here we have a natural elevation, sufficient for the lower reservoir *B B;* the fire reservoir, *C C*, being placed on artificial supports.

Figure 3 shows two reservoirs located on hills, sufficiently high for both purposes, the lower reservoir, *b*, being located at a proper elevation for domestic use, and the upper reservoir, *c*, at an elevation sufficient for fire purposes, both being constructed on the surface of the earth.

This system of reservoirs has been patented by John N. Poage, of Cincinnati, Ohio. [*Hydraulic Engineer.*]

FIRE PROTECTION.

CONCERNING SPONTANEOUS COMBUSTION.

III.

Spontaneous fires originating from the second cause—namely, from the slow combustion of porous substances—are of not infrequent occurrence; and from their very insidious character are a source of anxiety to numerous business interests in which they are liable to occur, as well as to insurers. Upon wharves, or in ships, warehouses, mills or workshops, occupied with the storage, transportation, manufacture or use of materials of this kind, amongst which may be enumerated sundry carbonaceous matters, or wool, tow, cotton, rags and the like, when impregnated with oils of various kinds, danger from this cause is especially to be apprehended and guarded against. The process in question is about as follows: The oily mass absorbs and condenses the air within the pores—and such carbonaceous substances appear to be endowed with the property of selecting and absorbing the atmospheric oxygen in preference to the nitrogen—the process of condensation is attended with the liberation of heat, oxidation at once is started, and progresses with accelerating intensity as the temperature increases, until at length the mass is inflamed. It is a fact of common experience, for example, that the animal or vegetable oils, when saturating such porous substances, will, especially when the latter are closely packed together, become heated by slow oxidation. The low conducting power of such masses, also, greatly facilitates the combustion by preventing the taking off and dissipation of the heat thus generated—a fact, by the way, that suggests one of the most effectual precautionary measures for avoiding accidents from this source, and which will be referred to further on.

Some illustrations of these statements, and of facts generically related to them, are herewith appended, from which a just estimate may be had of their dangerous character and of the proper precautions to be taken to guard against their occurrence. Before introducing these details, however, it should be noted that all authorities coincide in the statement, that the presence of water moisture materially aids the spontaneous ignition of porous substances; the water, in virtue of its eminent absorptive properties, acting probably as a carrier of oxygen to the combustible matter.

The specific form of spontaneous combustion that is of most common occurrence, and with which, therefore, the public is most familiar, is the ignition of oily cotton-waste, which is an accumulation in a great variety of factories and workshops. Indeed, so well aware are proprietors and managers of the insidious dangers of such accumulations, and that their ignition is neither an accidental nor exceptional phenomenon, that in the large majority of cases, and certainly wherever intelligent supervision exists, there will be stringent directions enforced concerning its disposition.

Without detailing specific instances of accidents occurring from the ignition of oily cotton, seeing that there will scarcely be one of our readers who will not be able to call an incident of the kind to mind, we will invite attention to certain experiments of an instructive nature, made by Mr. John Galletly,* with the view of determining the relative rapidity of the heating action of a number of oils when present in cotton-waste. In these experiments, artificial heat was employed to raise the temperature of the several masses to the degree that a body will reach when exposed to the vertical rays of the sun, or to that attained in the neighborhood of a steam-pipe or a heated flue. It will perhaps be well just here to digress for a moment, in order to consider briefly the probabilities of the origination of accidental fires from the steam-pipes used in buildings heated by steam—a theory that has lately found strong support in certain influential quarters. The inspection of our table of temperatures of ignition† has brought to light the important fact that, to ignite even the most combustible substances by heat alone, demands a considerable temperature, and one that in the vast majority of cases will not be reached save by direct contact of a spark or flame to some portion of their mass. Now, as the heat of super-heated steam ranges between 300° and 500°, it will be able to fire such substances as phosphorus, sulphur, gun-cotton and nitro-glycerin; it is, perhaps, able to fire gunpowder, but it cannot directly ignite wood. In view, however, of the possibilities of spontaneous combustion, it will be prudent to make the qualification that where well-dried wood, or sawdust, or rags, or cotton, or woolen-waste, and similar porous combustibles saturated with the vegetable or animal oils, enter into the question, the temperature may rise to the point of ignition. Though dangerous in any situation, as we shall presently prove, the collection of such pyrophores in establishments warmed by steam, in view of the possibility of their accumulation in contiguity to the heated pipes, is therefore rigorously to be avoided as peculiarly dangerous. By this statement, we by no means design it to be inferred that factories or workshops *not* heated by steam are therefore notably exempt from liability to this species of accident; on the contrary, statistics abundantly demonstrate the fact that the heats of summer, careless accumulation and deficient ventilation are responsible for vastly more spontaneous fires than the heating arrangements of factories and workshops.

To turn from our digression to the consideration of Mr. Galletly's investigations, we will repeat, for the sake of clearness, that this investigator employed artificial heat

* Journal Franklin Institute, vol. lxvi, 300. † *Vide* this Journal, ii, 5.

to raise the temperature of his various oil-soaked masses to the degree that a body would reach when exposed to the vertical rays of the sun, or to that attained in the neighborhood of a steam-pipe or a heated flue. According to his results, under such circumstances, spontaneous combustion took place in cotton-waste, soaked with boiled linseed oil, within seventy-five minutes from the commencement of the experiment. The temperature of the mass increased from 5° to 10° every few minutes, and in the time specified had reached 350° Fahr. At this point, the smoke issuing from the box indicated that the cotton was in a state of active combustion, and on exposing the mass to the free access of the air, it burst into flames. In a second experiment, similar to this, the temperature rose more slowly, but reached 280° in one hundred and five minutes, when from the appearance of smoke it was apparent that the cotton was burning, and the whole mass was in flames shortly after being exposed in a current of air. Raw linseed oil was found not to cause ignition of cotton so readily as the boiled oil, but under conditions quite similar to those of the foregoing experiments, active combustion was effected in one case in four and another in five hours. With rape oil, the result was that the box and its contents were found in ashes in ten hours (the experiment having been prepared at night, the result was only observed in the morning). Olive oil caused active combustion within five or six hours. With castor oil, the contents only charred on the second day of the experiment. Lard oil (sp. grav. ·916) produced rapid combustion in four hours; seal oil (sp. grav. ·928) gave the same result in one hundred minutes; sperm oil gave only negative results.

To a certain extent the conclusions which our author draws from his experiments are at variance with the opinions generally entertained by those well informed on this subject; but they confirm in a very satisfactory manner the important feature, that danger from this source cannot be safely ignored, and that, so far from being accidental or exceptional, such spontaneous fires take place according to a well understood and uniform law. With the proper conditions, he demonstrates, cotton-waste will ignite as certainly as will gunpowder from a spark. So uniform were the results of his experimental trials, we are informed, that the ignition of this substance can be calculated on, for any oil, with about the same certainty as the point at which sulphur or other combustible matter inflames in air.

Another interesting feature of this investigation resides in the behaviour of different oils, and here, as we noted just above, the author is led to a conclusion slightly at variance with the views generally held by writers on this topic, namely, that "drying oils are more liable to spontaneous combustion than non-drying oils." Prof. Graham, for example, in his "Report on the Cause of the Fire in the "Amazon," * says: "The practice of mixing together the various stores of the engineer, consisting of oils, tallow, turpentine, cotton-waste and tow, and placing them in heated store-rooms contiguous to the boilers, must be looked upon as dangerous in no ordinary degree, and for several reasons. Although oil in bulk is not easily ignited, still when spilt upon wood, or imbibed by tow and cotton-waste, which expose much surface to the air, the oil often oxidates and heats spontaneously, and is allowed to be one of the most frequent causes of accidental fires. *The vegetable and drying oils* [the italics are our own] used by painters are most liable to spontaneous ignition, but no kind of vegetable, or animal oil, or grease appears to be exempted from it; and instances could be given of olive oil igniting upon saw-dust; of greasy rags from butter, heaped together, taking fire within a period of twenty-four hours; of the spontaneous combustion of tape measures, which are covered with an oil varnish, when heaped together, and even of an oil skin umbrella put aside in a damp state." The close similarity in the constitution of the various vegetable tissues justifies the assertion that the results of Mr. Galletly's experiments with cotton-waste will apply with equal truth to the behaviour of the whole body of such substances—saw-dust, cotton, jute, hemp, flax, etc.—and that Prof. Graham's generalization is directly applicable to this author's results. Upon this point, the testimony of Mr. Braidwood,† who for many years was chief of the London fire brigade, is of especial value. He remarks, for example, that saw-dust in contact with vegetable oil is very liable to take fire; cotton, cotton-waste, hemp, and most other vegetable substances are equally dangerous. In one case, he testifies, oil and sawdust took fire within sixteen hours. In the same connection, another writer remarks: "Drying oils are worse in this respect (*i. e.* in their liability to spontaneous ignition), than others." And another: "We observe that the contact of the vegetable or drying oils with porous carbonaceous substances is most productive of spontaneous ignition."

Mr. Galletly's conclusions from his experimental trials do not coincide entirely with the generally received opinion concerning the superior liability of the drying oils to spontaneous ignition. He does not venture, however, to contradict the popular verdict, but declares that this rule is not asbolutely uniform in its operation, and that the rate at which oxidation with the different oils takes place, is not dependent chiefly upon the presence of small quantities of putrefiable matters, but rather upon the peculiar oleine, or liquid fat that they contain; and this conclusion he bases upon a comparison of the behaviour of the two classes of oils. The point made by Mr. Galletly is of considerable importance, inasmuch as the insurance interest at home and abroad does not hesitate to discriminate in its rates of charge in favor of some and against other oils employed under similar circumstances. Until, therefore, more extended investigation shall have given us a more precise and accurate insight into the behavior of this class of substances, his (Mr. G's) estimate of their relative freedom from, or liability to, ignition, is deserving of the trustworthy consideration of all whose interests are involved.

In several respects, however, Mr. Galletly's investigation is unsatisfactory and incomplete. He confines his experiments, in the first place, to the vegetable fibres, and takes no consideration of the behavior of wool or silk; and in the second place, he gives us no hint concerning the influence of moisture, which is generally conceded to be an important modifying factor of the causation of spontaneous fires in substances of this nature.

To show the prominence of the influence which it (moisture) is generally believed to exert in hastening or modifying such combustion, we append the following characteristic statement of a prudent and highly esteemed authority. * Referring to the "sweeps," which are the ordinary product of all cotton mills, and are soaked with oil, the remark follows: "These are constantly sent by scores, even hundreds of tons, by steamer and railway to London, packed in bags containing from one to one and a half hundredweight, and in no case during the last thirty years has a tendency, or still less, a sign of spontaneous combustion been recorded, *provided no water moisture was present.* We have seen several hundred bags of such 'sweeps' piled on each other during the whole of a hot summer, perfectly free from heating, in a place where little or no ventilation existed. But a similar class of 'sweeps,' say in a voyage from Aberdeen to London, placed on deck and exposed to the rain, has been received in London in such a heated condition as to require unpacking and exposure to the air, to allow the waste to cool down."

In addition to this testimony, we might adduce the fact observed by a committee of the Franklin Institute, appointed to investigate this subject, that in every case, independently of the nature of the oil employed, the ignition of cotton-waste was invariably hastened by the presence of moisture. And again, the authority of Watt,† who asserts that "the presence of moisture greatly promotes the ignition of porous materials, the water probably supplying oxygen to the combustible matter. So far, therefore, as the investigation of Mr. Galletly establishes the fact of the occurrence of spontaneous combustion with cotton-waste (and we may safely add, of other vegetable fibre) as a phenomenon that is neither exceptional nor accidental, but occurs with certainty on the recurrence of certain well understood circumstances—and furthermore, that the behavior of the various oils in this respect is peculiar, his conclusions are valuable and are entitled to a respectful consideration. A thorough investigation that shall embrace every phase of this peculiar subject has yet to be made.

Before leaving this branch of our subject, we cannot omit to notice one very suggestive observation of Mr. Galletly's, namely, that the heavy oils from coal and shale were found to effectually check the tendency to spontaneous firing, for he states that when these were mixed with the oils employed in his experiments, they gave no indications whatever of heating at 170°. Of the utility of this observation we shall have more to say hereafter. Again, what has been said of the behavior of cotton-waste, will apply unconditionally to the other vegetable substances—oily paper, sawdust or wood-shavings, jute, the several varieties of hemp, flax, etc. To enumerate specific examples of spontaneous ignition with each of these, would, therefore, only be to unnecessarily lengthen this paper, without contributing materially to the strength of its conclusions.

As an illustration of the crude and erroneous notions that sometimes gain public credence through the medium of the technical press, we reproduce in full an item that first appeared in one of the English journals, and was subsequently copied far and wide in this country, and which for extravagant absurdity will bear off the palm from anything of a kindred character that we have lately met with, viz:

"When oxide of iron is placed in contact with timber excluded from the atmosphere, and assisted by a slightly increased temperature, the oxide parts with its oxygen, is converted into very finely divided particles of metallic iron, having such an affinity for oxygen that when afterwards exposed to the action of the atmosphere from any cause, oxygen is absorbed so rapidly that these particles become suddenly red hot, and if in sufficient quantity will produce a temperature far beyond the ignitable point of dry timber. Wherever iron pipes are employed for the circulation of any heated medium, (whether hot water, hot air, or steam). and wherever these pipes are allowed to become rusty, and are also in close contact with timber, *it is only necessary to suppose* [italics are our own.—ED.] that under these circumstances the finely divided particles of metallic iron become exposed to the action of the atmosphere (and this may occur from the mere expansion and contraction of the pipes), in order to account for many of thefires which periodically take place at the commencement of the winter season."

It is *only* necessary to suppose a thing that any tyro in chemistry will pronounce to be impossible in order to explain the whole subject.

It is, doubtless, true that wood-work in the immediate vicinity of heated steam-pipes will in time become so thoroughly dried, and even at times *charred*, that on contact with a spark as from the careless throwing of a match or cigar, it will ignite as freely as tinder; but it borders on the ridiculous to manufacture such fanciful speculations as the above, where there is no mystery to be explained. W.

* Jour. Chemical Society, (Qu.) V, 34.
† Sci. American, (2) xxi, 243.

*Engineering, June, 1874. † Dictionary of Chemistry, Vol. I, 1093, Art. Combustion.

[*To be continued.*]

STRENGTH OF BAND SAW BLADES.

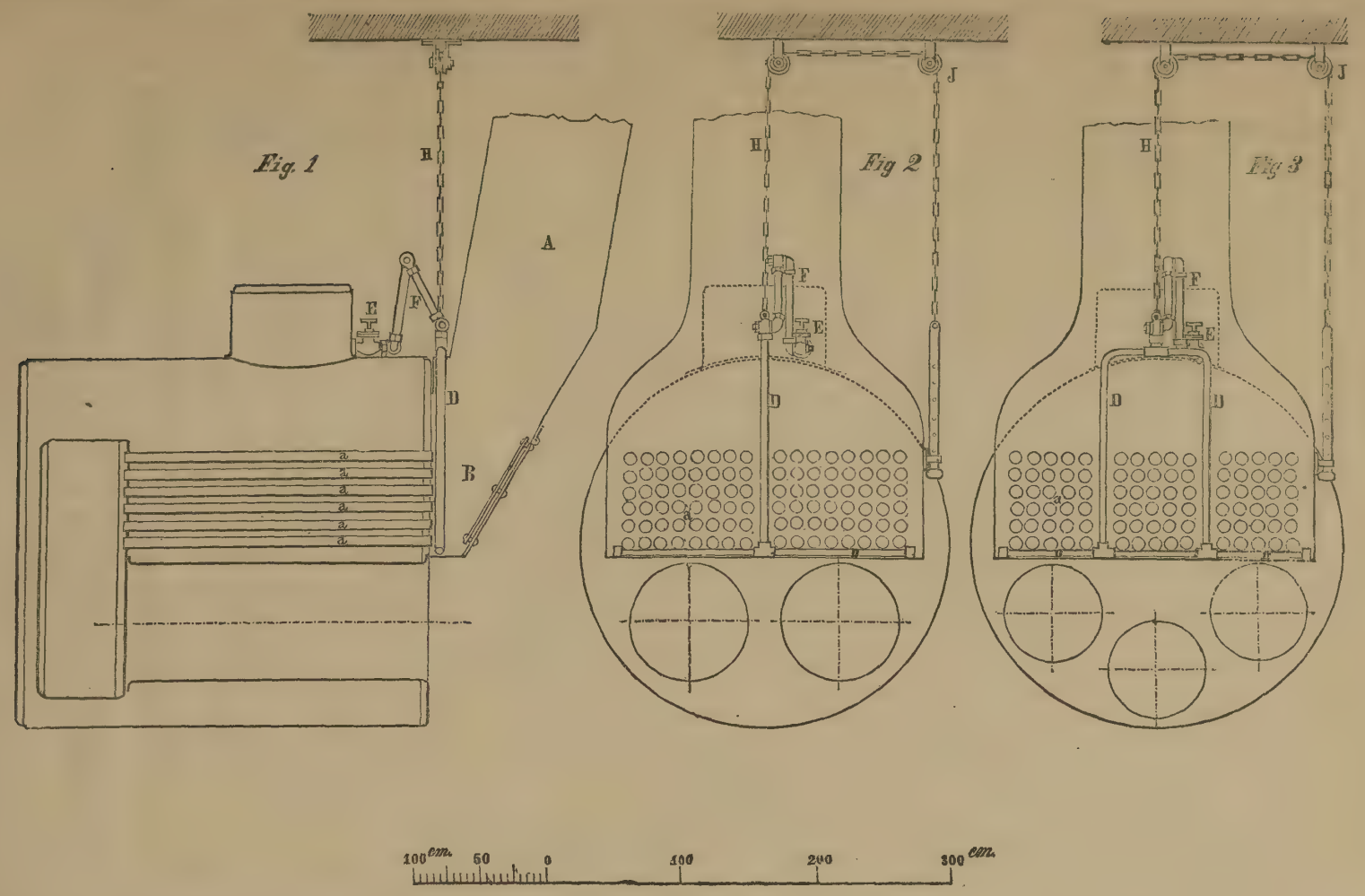
Test of the strength of eight specimens of Perrin's Band Saw Blades, with brazed joints, by Richards, London, & Kelley, made on Riehlé Bros.' Testing Machine, July 19.

No.	Thickness.	Width.	Width nearest 1-16th inch	Breaking weight.	Strength, sq. inch.
1	·0346	1·05	17/16	7600 lbs.	209,193 lbs.
2	·0353	·62	10/16	4000	182,765
3	·0365	·745	12/16	6000	220,649
4	·0337	1·062	17/16	3000	83,823*
5	·0310	.625	10/16	2230	115,090†
6	·0310	·490	8/16	2000	131,060†
7	·0335	·280	9/16	2000	213,210
8	·0310	·094	3/16	485	16,430

* Broke at end of joint. † Broke across center of joint.

The average strength of the unjoined pieces was 446 lbs. for each 1-16th inch in width; and the strength of the weakest (which were the narrowest also), 323 lbs.; while the average strength through the joints, for each 1-16th inch in width, was 206 lbs. per 1-16th inch; in the weakest, 176 lbs. All the blades for the ordinary saws are made of No. 19 B. W. G. steel, and vary only by the inequalities caused by grinding or filing the joints. The knowledge that when a band saw is being strained to the amount of 175 lbs. for each 1-16th inch in width, is strained to nearly its limit of endurance, may be of some value to the makers and users of band saws.

JOHN E. SWEET.



W. S. VON ESSEN'S APPARATUS FOR CLEANING BOILER TUBES BY STEAM WITHOUT OPENING THE DOORS OF THE SMOKE BOX.

GERMAN SECTION, MACHINERY HALL, CENTENNIAL EXHIBITION.

"Every practical engineer must be aware of the great disadvantages connected with the present method of cleaning the boiler tubes by common scrapers or brushes. On opening the tube doors a strong current of cold air rushes through the tubes; it causes them to cool suddenly and to contract, and often leakages, especially on the back tube plate, ensue. This great disadvantage increases with boilers fired at both ends where the heat in the flame chamber is necessarily greater.

Further, by opening the tube doors the draught in the boiler is cut off, the fires are checked, the steam-pressure decreases, and with it the speed of the vessel; and as the full pressure is not recovered without much trouble, extra consumption of coal and delay, the consequence is, that during a long passage, where the operation has regularly to be repeated, the vessel loses much time, and the expenses are increased.

It is claimed that all these disadvantages are avoided by the apparatus illustrated herewith, as applied to marine boilers.

The principal advantages aimed at by this invention for ship and stationary boilers are the following:

1. Leakages that commonly arise at the back tube plate, from the sudden admission of cold air through the opening of the smoke-box doors, are avoided.

2. Saving of coal, as the tubes are easily kept clean, and in consequence will yield more heat than hitherto.

3. The steam pressure does not decrease during the cleaning of the tubes, as the draught is not checked by open smoke-box doors. The operations of cleaning hitherto used involved decrease of pressure and speed, which could only be regained by enforced development of steam.

4. Saving of time and labor, as by this system the cleaning of all the tubes of even the largest boiler is effected within a couple of minutes.

5. A better and more complete cleaning of the tubes than by hand, and applied on stationary boilers at the same time, a complete cleaning of the back tube plate, side channels and chimney, as the apparatus cleans with the draft of the boiler and carries along the soot out of the channels and chimney.

6. The cleaning of the tubes is effected without exertion to the stokers. The operations as hitherto in use cause intense suffering to the men from heat, especially in hot climates. Stagings that have to be erected with large boilers are dispensed with.

The accompanying drawings represent the apparatus as applied to marine boilers.

a a are the tubes of the boiler. A is the chimney. B is the smoke-box.

The cleaning apparatus consists of the bent pipe, D D, which is placed inside the smoke-box or combustion chamber. Applied to steamship boilers, the lower horizontal part of this pipe is suspended below the bottom row of tubes inside the smoke-box, to prevent its being exposed to the flames; and applied to stationary boilers, where the apparatus is placed inside the combustion chamber, the horizontal pipe is in place of rest above the top line of tubes. This part of the pipe is furnished with small perforations which correspond with the centres of the tubes. The pipe D D is in communication with the steam of the boiler through the jointed pipes, F F, and the valve, E. By means of the lifting apparatus, H, I, K, the pipe, D D, is lifted and lowered from outside the boiler and smoke-box.

When the tubes are to be cleaned, the pipe, D D, is brought before the bottom row, and then the valve, E, is opened. The steam from the boiler enters the pipe, D, rushes through the tubes and cleans them thoroughly. Pipe D is lifted successively to every row of tubes and a jet of steam applied to each. After the operation, pipe D D is brought back into its first protected position.

According to the construction of the boiler and the arrangement of the fire tubes, the pipe D D and its connections with the steam and lifting apparatus must be modified.

A great number of apparatuses have already been applied on board of ships, and it is thoroughly proved that scrapers and brushes can be altogether dispensed with, even on the longest voyages.

The firemen are not molested by ashes or dust, as the soot, together with the small quantity of steam admitted to one row of tubes, is carried away by the draught through all the other tubes into the chimney."

The apparatus is highly endorsed by German marine engineers.

THE PRACTICAL TECHNOLOGICAL INSTITUTE OF ST. PETERSBURG.

The Practical Technological Institute of St. Petersburg is one of the highest technical schools now existing in Russia, and has capacity for five hundred students. It is divided into two departments: mechanical and chemical.

The Mechanical Department prepares technical men for the management of mechanical workshops, and of the rolling stock on railroads. Owing to this the Mechanical Department is divided into two special sections; one of them graduates engineers for the workshops, and the other for the railroads.

Before entering the Institute as student, the young man must be graduated in one of the middle schools (gymnasiums), and must undergo a competitive examination.

The whole course of instruction in each department of the Institute is arranged for five years, and is divided into five yearly courses.

In the Mechanical Department the course of instruction includes: mathematical analysis, natural philosophy, theoretical and practical mechanics, mechanical technology, the art of construction and the art of mechanical drawing. Besides this, a part of the time is employed by the students in manual labor in various workshops and mills belonging to the Institute.

During the full five years of the course of studies, six hundred and forty-eight hours are devoted to the manual labor in workshops. There the students, under the management of experienced masters, begin to exercise in the most simple works, gradually passing to more complicated, and at last finishing with construction and joining of all the parts of an engine.

The collection of practical works exhibited in Machinery Hall by the Institute is composed of articles manufactured by the students during the year 1875, and represents the systematical course of practical studies adopted by the Institute.

The system introduced with this purpose is as follows: The practical studies are divided into three courses; for the first course each student is induced to work with a chisel and file upon the cast-iron, performing six consecutive tasks exhibited under No. 1 of the collection.

For the second course the students begin by working upon wrought-iron, fulfilling nineteen consecutive tasks represented under No. II of the collection. Thereafter they are removed to the fitting-shops, where they are obliged to perform fifteen tasks, exhibited under No. III of the collection, occupying themselves with turning, cutting screw-threads and soldering.

The last course is intended for the construction and joining of different engines. The samples of machine tools built by the students of this course are exhibited under No. IV of the collection.

The exhibit is under the charge of Prof. August Peters, of the Institute.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

Further Projects for the Improvement of the Navigation of the Mississippi.—The last advices from South Pass show that the work of scouring out the channel between the jetties is progressing favorably and satisfactorily. Since the closing of Grand Bayou, the amount of earth removed from the channel way has been very great. Each day's soundings indicate that the jettied channel is gradually becoming straighter, wider and deeper. From a point within 300 feet of the head of the Pass to a point within 1,000 feet of the sea end of the jetties there is a clear wide channel of considerable over 20 feet in depth. The official survey, made on the 13th of July, showed a depth of more than 20 feet of water on this 1000 feet, with the exception of 450 feet, where several soundings indicated a less depth than 20 feet, but not less than 18½ feet. On July 18, however, on this space of 450 feet, the soundings showed a depth of over 20 feet, with three exceptions. One sounding indicated 19 feet and two 19½. These three soundings extended over a space of 75 feet in length up and down the channel, showing that from 20 feet depth inside to 20 feet outside the distance was but 75 feet, with the least depth there of 19 feet. The action of the current upon the mud lump, outside of and in front of the jetties has been very effective. This mud lump, it will be remembered, has been constantly spoken of by the opposers of the jetty system as an obstacle sure to defeat the success of the jetties. The latest survey, however, shows that the current has divided this lump in two parts, and that through it now, there is a channel over one hundred feet wide and twenty and a half feet deep, which channel is every day deepening and widening. The ship James A. Wright was towed through the jetties yesterday by two towboats. Captain Morrison of this vessel stated that he thought in a very short time he would be able to take his ship through South Pass loaded to the depth of twenty-two feet.

For the improvement of the entrance to South Pass, Captain Eads has already settled upon his plan, and the preparatory surveys are now being made. The plan embraces a system of wing dams and dykes, the object of which is to confine the water to a much narrower space than it now occupies, and to increase the current and scour. An official survey made some time ago showed that the shoal extended from the head of the Pass, up the river for a distance of two thousand feet, and from the head of the Pass, down the Pass for a distance of three hundred feet. Over this two thousand feet the depth of water was from sixteen and a half to seventeen feet, and over the three hundred feet, from 19 to 20 feet. To make a deep and permanent channel through this shoal Captain Eads proposes to build a series of wing dams. Two wing dams, one on either side of the river, will be placed 3,000 feet above the head of the Pass. The one on the left bank going down will extend into the river from the bank 1,400 feet, and the one on the right 1,250 feet. The space left between these two dams for the passage of the water will be 5,000 feet. At a distance of 2,400 feet below these will be placed two more wing dams. The one on the left side going down will be 1,200 feet in length, and will jut, at a right angle, from a dyke 3,200 feet in length, already built and known as the east dyke, running from a point 800 feet below the head of South Pass to a point 800 feet above this dam. The dam on the right will be 600 feet in length and will have neither dyke nor bank as a base. The open space between these two dams, for the current, will be 800 feet, which is about the average width of South Pass. This system of dams and dykes will leave a passage into the Southwest Pass of 2,400 feet, and a passage of the same width into Pass-a-l'Outre. Work will be commenced on these dams as soon as the surveys are completed, and it is confidently believed that a depth of water of twenty feet or more will be obtained at the head of the Pass in a very short time. [*N. O. Bulletin.*]

Oil Pipe Lines.—The total mileage of iron pipe used in the oil region is placed by good authority at not far from 1,500 miles, some asserting 2,000 to be nearer the truth. This is owned by the following pipe line companies: Atlantic, Union, Keystone, Antwerp, Relief, Sandy and Milton, United, Grant, Pennsylvania Transportation, American Transfer and Conduit. The principal area of these pipes lies in Butler county, where the producing districts are far apart, and the farms in some places are covered as by huge spider webs. The Conduit Company has over one hundred miles in use, including forty-eight miles of main pipe three inches in diameter, and forty-eight miles of "connections," of two inch pipe. Before a gallon of oil was pumped, this line cost $400,000. Taking 1,500 miles of the quantity of pipe in use, and the cost of laying to be thirty-five cents per foot, it appears that $2,772,000 is invested in pipes alone. The cost of pumps, tanks, etc., will swell this to double the amount. [*Chicago Railway Review.*]

The Hudson River Tunnel.—Active preparations are now in progress for the construction of the Hudson River tunnel on the Jersey shore. The entrance to the tunnel is located on Jersey avenue, near Fifteenth street, and the excavation will be carried in a north-easterly direction, terminating in Washington Square, New York. The tunnel will be two miles in length, and it is calculated the cars will pass through it in three minutes. The road bed will be twenty-three feet in width. The shaft at the foot of Fifteenth street, Jersey City, is 100 feet in circumference and the brick wall is three feet and four inches thick. The shaft has been sunk to the depth of twenty feet, and will be further excavated to the depth of sixty-two feet, when the excavation beneath the river will be commenced. The machinery for the work is now in position, and it is stated that the excavation of the shaft will be completed within twenty days. The eastern grade of the tunnel is two in a hundred feet, descending from Jersey City, then ascending on the New York side two in a hundred feet. As soon as the shaft is sunk to the required depth, a few feet will be excavated in the tunnel, when an iron cylinder with hinged doors will be inserted, so that the laborers can proceed with the work. Compressed air will be forced from the surface into the cavity. Very little blasting will be necessary; the first vein of rock being 1,100 feet from the New York side, and the rock is soft. The depth of of earth over the masonry will not be less in any part than thirty-five feet, so that no injury can occur from the anchorage of vessels. The cost of this stupendous enterprise will be $15,000,000, of which $10,000,000 has been already subscribed. After several legal contests the Hudson River Tunnel Company has been triumphant, and the president, Colonel Haskin, declares his determination to proceed vigorously with the work. [*N. Y. Herald.*]

The English Channel Tunnel.—The experimental boring at Sangatte, near Calais, is being rapidly proceeded with, and had reached, in the beginning of the week, a depth of about 300 feet. Its object is to ascertain the thickness and condition of the cretaceous strata through which it is proposed to carry the channel tunnel. The soundings taken across the straits in autumn last, over a belt of from one to five miles wide, a little to the west of the line where the tunnel is proposed to be made, showed that no break exists in the strata, and that the dip nowhere exceeds 10 per cent. This year it is intended to make a series of soundings in English waters to settle whether an observed divergence of the chalk towards the north is due to a break or owing to dip, and another over the line of the tunnel to ascertain whether a particular stratum of chalk comes there to the surface, and to take additional soundings in the portion of the channel already examined. The general opinion among geologists is that no important flaw exists in the chalk, and that opinion Sir John Hawkshaw considers to be confirmed by the explorations of the bottom already made. There is a narrow level belt in mid-channel, whence the bottom gradually slopes upwards to either shore. It is intended to sink the boring at Sangatte about two fathoms below the gault, and when all these preliminary operations are completed, a well will be sunk and a heading driven under the channel. With modern science and appliances, and the large experience which many similar and some almost as extensive works have given, the completion of the tunnel will involve no extraordinary difficulty. It is interesting to know that the execution of this project was seriously discussed by Napoleon and Fox, and that even then it was an old scheme.

In anticipation of this important engineering work of piercing the chalk formation under the channel, the ingenuity of the English inventor seems to have found full scope. As the Mont Cenis tunnel originated novel drills and the use of compressed air as a motor, so will very probably the channel tunnel call into play new apparatus. If the theory of the geologists is correct, the mechanical difficulties will not be anything as great as for either the Mont Cenis or St. Gothard tunnels. At present a machine has been working in an experimental way in England, applied to the face of the chalk, which seems to do its work quite effectively. The machine works like an auger, cutting off the chalk in slices, which, when broken up, are removed by means of endless bands. This machine makes a drift of seven feet in diameter, and its advance is at the rate of a yard in fifteen minutes. If, then, this rate of speed could be made constant, by having two machines working from opposite ends, the channel drift would meet in about two years. It is estimated that the cost of making this seven-foot tunnel would be $2,000,000, and to increase it to the proper working size, $20,000,000 more would be required.

Pullman Palace Cars are coming rapidly into favor in England. The Midland Railway has 25 in operation, and 44 building.

A Feed Water Indicator is patented, and shows whether or not the current of water is passing from the pump to the boiler.

Newport Water Supply.—Mr. Geo. H. Norman is to build the water-works of Newport, R. I., and to have the exclusive right of supply for fifty years. The works are to cost $600,000. [Abr. from *Eng. News*, iii, 226.]

The Last Brick in the Hoosac Tunnel is laid. Steel rails are ordered for the whole distance between Greenfield & Bradwell's Ferry.

The St. Gothard Tunnel.—The monthly progress is 380 ft. at the northern end, 200 ft. at the southern. About 10,000 ft. are completed at each end; 50,000 ft. remain. The work should be completed in 1883, at the present rate.

Pontoon Bridge at Omaha.—The Missouri River will be bridged at Omaha by a pontoon bridge, of Klein's patent. [Abr. from *R. W. Review*, xiii, 28.]

A New Car Brake has a shoe brought up against the under side of the rail head, by means of levers and eccentrics.

A New Car Truck is being built by Billmeyer & Smalls, York, Pa. The axle is severed in the centre and has a box in which the inner ends of each half axle work. It is intended for rounding curves readily.

MINING, METALLURGY AND MINERALOGY

The Bessemer Steel Manufacture is renewed as follows in a recent issue of the *Moniteur des Interes Materials.*

Great Britain heads the list with 21 Bessemer works and 105 converters; Prussia is placed next with 14 works and 61 converters; Austria 12, with 30 converters; Bavaria 2, with 4 converters; Alsace 1, with 2 converters; France 8, with 25 converters; and the United States 8, with 16 converters; making a total of 67 establishments with 247 converters, which collectively are estimated as capable of producing, if required, 2,500,000 tons of Bessemer steel per annum.

These estimates are certainly not strictly reliable, for as a contemporary notices, neither Belgium, Sweden nor Russia, each of which possess Bessemer establishments, are taken into consideration.

With regard to the United States, the number of establishments as given is too low, for during the year 1876 there were 10 completed Bessemer works in operation, and at least one more in course of erection.

An Explosion lately occurred in the Black Diamond mine at Mount Diablo, California, occasioned by a blast igniting the accumulated coal-dust.

A Deposit of Emery of some magnitude is affirmed to have been discovered near Thurman Station on the Adirondack Railroad some sixty miles from Troy, New York. The deposit is now being worked by a large force of miners. [*E. & M. Jour.* xxii, 77.]

Washington Territory Coal Fields.—A line of the Northern Pacific Railroad is contemplated from Tacoma, on Puget Sound, up the Puyallup River a distance of thirty miles. General George Stark, General Manager of the North Pacific Road, is now on his way to Tacoma to examine the route of the proposed road and report to the directors of the company. Should this road be built it will penetrate the coal fields owned by the company, and enable consumers on this coast to procure fuel at a great discount from the price now charged. The company has sent experts, who are thoroughly conversant with all qualities and kinds of coal, into Washington Territory, to make a thorough examination of the deposits, and they report that the quality of the coal to be obtained from these fields is far superior to any now produced on this coast. To give an idea of the scarcity of good coal on the Pacific slope, it is only necessary to state that during the year 1875, as much as 140,000 tons were received in San Francisco from Australia alone. As the Pacific Mail Steamship Company's steamers penetrate Puget Sound and touch at Tacoma, the facilities for transportation to this port will be excellent. [*Mining & Sci. Press*, xxiii, 45.]

The town of Manayunk (a suburb of Philadelphia) will shortly be lighted upon the Lowe Gas system. Works for that purpose, with the consent of the city authorities, have been for some time in course of erection, and are about ready to go into operation.

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Silvering Metal Goods.—The following process for giving a durable silver-like lustre to all kinds of metal goods, is proposed by Dr. Kayser of Nüremberg. Five parts of pure tin (the Australian is given the preference from its purity) are melted with one part of copper, and the molten mass granulated in the usual way. The granulation should be rather coarse than fine. The granulated metal is prepared with water and cream of tartar as free as possible from lime. To 100 grammes of metal, about 0·5 grammes of ignited nickel oxide is added, and the object to be treated is laid in the bath. After boiling for a short time, the object becomes covered with a film having the exact appearance of silver, with the advantage of possessing a greater resistance to wear than tin or silver alone. The nickel in the bath must be renewed from time to time. Copper or brass goods can be silvered without preparation. Iron goods need coppering first. If carbonate of nickel be added a film is obtained that is richer in nickel and darker in color, which can even be intensified to a blue black by increasing the amount of nickel. [*Iron*, viii, 74.]

Utilization of Leather Waste.—The following method for manufacturing artificial leather from leather refuse has been patented abroad by Herr Sörensen, of Copenhagen.

In case the leather waste is unclean it is first to be washed, after which it is reduced, in a machine specially constructed for the purpose, to a uniform and fibrous condition. This operation may be effected either by tearing, stamping, cutting, rasping or rubbing. When reduced to this finely divided condition, the leather is treated with ammonia water, by which it is converted into a gelatinized mass, which, when pressed into moulds, or rolled out between rollers, and dried, makes a very hard and stiff product, having considerable cohesiveness, but without elasticity and soluble in water.

In order to give the fabric elasticity and to render it indifferent to water, it is treated with rubber by the following method. The rubber, of which no special quality is required for the purpose, is bruised and washed in a washing machine consisting of two channelled steel rollers, upon which a stream of water is allowed to flow, for the double purpose of cleansing the rubber and to protect it against charring from the great friction. After washing, the rubber is cut into strips and dissolved in turpentine, benzine, bi-sulphide of carbon, or other solvent. The quantity of rubber employed, as compared with the quantity of solvent, will depend on the quality of the former. Para rubber, for example, will require 4 parts of the solvent; Central American 'scraps,' 3½ parts; Guayaquil, 3 parts, and African, about 2½ parts. The rubber thus prepared is mixed with the ammonia water and well stirred. Then the prepared leather fibre or pulp is brought into it in a closed kneading machine. The proportions of ammonia and rubber to be used will vary according to the quality that the product is designed to have; for example, one should use—

For soles,	25	parts solid rubber.
	67	" ammonia.
	67	" leather.
For heels,	25	" rubber.
	80	" ammonia.
	80	" leather.
For inside soles,	25	" rubber.
	75	" ammonia.
	90	" leather.

After the kneading, which should continue until the mass is perfectly homogeneous, the product is removed and either pressed into forms or rolled out between rollers. It is then dried, and during the operation of drying it is to be subjected to a series of pressures, the strength of which is to be regulated according to the character of the product. For soles, for example, the greatest pressure, namely, 6000 lbs. per sq. inch, is used. When pressed and dried, the product is either colored or lacquered, or in some other way treated to make it imitate the genuine article most closely. [*Bay. Industrie u. Gewerbe Blatt* viii, 140.]

A New Electric Battery, by Mons. Onimus, has a parchment paper porous diaphragm, covering a zinc cylinder; copper wire being wound over all. The whole is plunged in the sulphate of copper solution. Or, the inner cylinder may be of carbon, and the outer wire of zinc, any proper exciting fluid being used.

Purification of Oils.—A process said to be employed with success in England, consists, instead of agitating the oils by mechanical means, in agitating it by forcing a stream of air through it by means of a system of perforated pipes at the bottom of the containing vessel. Sulphuric acid is cautiously added to the oil during the operation, and the remainder of the process follows the usual course. [*Polyt. Notizblatt*, 1876, 32.]

A Russian Scientific Congress is appointed to meet at Warsaw next September, at which the question of adopting the Gregorian calendar will be considered.

A Green Varnish for Metallic objects may be prepared by dissolving as much sandarach or mastic as will be taken up in strong caustic potash, then diluting the solution with water, and adding a solution of a copper salt (either sulphate or acetate). The green precipitate is then to be washed, dried, and dissolved in turpentine. [*Bay. Ind. u. Gewerbebl.* viii, 155.]

A New Substitute for Animal Charcoal is affirmed to have been found in an oil shale in Dorsetshire, England, which yields an abundance of gas and a plentiful residual carbon, which is claimed to have precisely the same properties and action for all sanitary purposes as animal charcoal that costs $70 to $90 per ton. A number of crucial experiments were successfully made with it in purifying sewage water and water impregnated with dye stuffs.

Sugar-Water as an Antidote to Lime.—Bricklayers, plasterer, and others engaged in building are aware of the corrosive action of lime when a particle by accident happens to enter the eye. The use of cold sugar-water is affirmed to completely neutralize the caustic of the lime, and forming a neutral compound with it. [*Mittheil d. Architekt ü Ingen. Vereins im Königr. Böhmen.*]

—The best means of producing a black surface on brass, pinchbeck or silver, is said to be platinum chloride, which has been allowed to liquefy by exposure of the crystals to the air. The liquid should be applied with the fingers and rubbed. After blacking, the object is washed and polished with oil and leather.

—It is affirmed that zinc may be so hardened as to be worked at the lathe and file, by adding to the metal before casting from 5 to 10 per cent. of sal-ammoniac.

MISCELLANEOUS.

JENNINGS' PATENT LATRINES.

Jenning's Patent Latrines, shown in the accompanying cut, are arranged in sets or rows, connected in a single hydraulic system, so that by the simple motion of a handle they are all thoroughly cleaned at the same time by the sudden rush of the water contained in them.

An Oil Pipe Three Hundred Miles Long.—The Pennsylvania Transportation Company has been chartered by the State of Pennsylvania for the purpose of transporting oil from the oil regions to the principal Atlantic seaboard cities. The plan proposed is to run the oil through a four inch pipe laid on the surface; the forcing power will be nine hundred pounds to the square inch; there are to be stations at distances of fifteen miles, at each of which an engine of a hundred horse power will be erected to work a pump to continue the flow from point to point. The company having decided upon the construction of the work, the president sought the services of General Harman Haupt, of Hoosac tunnel fame, and who, during the war, was chief of the Bureau of Military Railroads, who pronounced the scheme, after a thorough examination, to be entirely practicable, and he is now acting as engineer-in-chief.

In view of the enormous product of oil in this country—thirty thousand barrels per day—and the rank it now holds among the leading articles of export, coupled with the exorbitant charges for railroad carriage from the wells to the seaboard, by the completion of the enterprise and its successful operation, a complete revolution will be accomplished in the handling of this article.

The estimated cost of the entire work, including fixtures, etc., is one and a quarter million dollars.

The Pennsylvania Company is the parent company, but there is also the Baltimore Transportation Company, chartered by the State of Maryland, and some five other companies are expecting to unite. The first objective point or terminus will be Baltimore, as being the most feasible and direct route for the pipes. Following which other termini will be established, in Philadelphia, New York, etc. The pipes being laid on the surface and there being no obstacle in the way of forcing the oil to any height, the line will literally be an air line, and the distance from the oil regions to Baltimore is three hundred miles. The oil will be distributed from the pipes into immense reservoirs with refining establishments adjacent.

The feasibility of this enterprise, so far as the passage of the oil through the pipes is concerned, has been fully established by the present system in operation in the oil regions, where the aggregate length of the pipes conveying the oil from the several wells to the reservoirs is nearly two hundred and fifty miles. [*Boston Traveler.*]

The Death-Rate in Carlisle, England, is reduced to 11 per 1000 per year, as the results of sanitary safeguards and supervision.

Aerotherapy.—The "compressed air" treatment is being revived in Milan, by Dr. Carlo Forlanini, who claims for it increased blood-oxygenation.

The Modern Shirt of Nessus.—Cases of poisoning from colored stockings, etc., are still quite common. Aniline red, and picric acid browns and yellows, are the most dangerous.

Poisonous Canned Meats.—The fraudulent use of leaded instead of tinned iron has given rise to many distressing cases of poisoning from eating canned fruits. More recently, cases of poisoning from eating canned corned beef, etc., have come to notice; and have been shown to result from the use of mercurial solder in the factories.

Waste Tobacco is largely used in England for sheep-wash; each gallon of which contains the essence of 24 ounces of strong American leaf.

Technical Education.—The *Engineering News* (iii, 225) calls for enforced technical education of engineers, and an examination before admission to practice; as in law, medicine, and other professions. We endorse the idea.

Classification of Clouds.—Whenever, on account of some topographic circumstances, the sun heats any locality on the surface of the earth more than the surrounding region, a gentle current or column of heated air rises, and its invisible moisture is condensed into small masses of clouds called *cumuli*, which spread and produce the mottled appearance commonly known as "mackerel sky."

But when, as is frequently the case in summer, a valley or plain, or island, or any other place, is much more highly heated by the sun than the surrounding region, the heated air over such locality rises more rapidly and with more ascensional momentum; and, as it reaches the higher and cooler regions of the atmosphere, its moisture is condensed into large rounded volumes, or mountain-like masses of *cumulus* clouds. Such *cumulus* clouds always precede and characterize a local summer storm or shower.

When the warm horizontal current from the south, as in winter, meets with the cold current from the north, it slopes upward over the cooler current, and forms stripes or bands of *stratus* clouds along the horizon.

These *stratus* clouds indicate to the observer the fact that a warm current is northward.

When in summer a cool current is moving southward, it encounters the warm equatorial or tropical current, which again glides upwards and over it, and forms horizontal bands of *stratus* clouds along the upper line of contact, as in winter storms; but, in addition, the denser cold air from the north, moving with more momentum, will lift up the warm and saturated air from the tropics, and its moisture will be condensed into masses of *cumulus* clouds banked up against the top of the old current, and arranged over the horizontal *stratus* clouds. Thus is produced the combination of *cumulo-stratus* cloud, which is characteristic of progressive summer storms.

To the tornado-cloud produced by a whirl of air, and resembling an inverted cone, Prof. Blasius gives the name of *conus*, which is both distinctive and appropriate.

These four typical classes of clouds—viz, cumulus, stratus, cumulo-stratus, and conus—indicate and characterize the four different classes of storms. ["*Blasius' Theory of Storms*," *in Popular Science Monthly.*]

The Marriage of Near Kin.—An interesting fact in connection with this debated question was brought out in the speech made by Sir Edmund Beckett, in his capacity as chairman of the annual festival of the West-End Branch of the Royal Association in Aid of the Deaf and Dumb. He stated that one of the cases requiring assistance from the society was that of a gardener, who had eight children born deaf and dumb. These eight deaf-mutes were the children of cousins; and Sir Edmund Beckett went on to remark on the common occurrence of several deaf and dumb children in one family, and especially in families where the parents, though not deaf and dumb themselves, were cousins. [*British Medical Journal.*]

Measuring Distance by Sound.—Major Le Boulanger, of the Belgian Artillery, on seeing the flash or smoke of a gun, by touching the key of a chronograph; and on hearing the sound, touching the key again, determines the distance of the gun within 50 feet, corresponding to about 1-20 second of time. This is of great advantage for coast defence against an attacking fleet, enabling the gunners to determine the distance of an attacking ship. [Abr. from *Manuf. and Builder*, viii, 157.]

To Harden Plaster Objects, it is recommended to add to it some three or four per cent. of powdered althea root (marshmallow). The resultant mass, in about an hour after setting, will be found to have acquired such a degree of hardness that it may be turned, sawed, etc. Buttons, dice, dominoes, etc., are made from it.

CENTENNIAL NOTES.

KEYSTONE BRIDGE COMPANY'S EXHIBIT.

Location—T 66, No. 4512, South side of Main Building, second door from east end.

II.

"Details of Steel Arches of the Illinois and St. Louis Bridge.—This exhibit illustrates the method of forming and uniting the steel tubes used in the arches of the St. Louis Bridge.

The tubes are composed of six rolled cast-steel staves forced into an envelope of steel. The sections between the joints are about twelve feet in length, and the depth of the arched rib, between the centres of the two concentric tubes, is about twelve feet. The two lines of tubes are braced, as shown in the detail. The ends of the tubes are united, as shown by couplings made in two parts with projections turned on inner surface to fit into corresponding grooves on the ends of the tubes. The pin is tapered and driven tightly into the joint. The lateral struts, diagonals, and lateral bracing between the several arches are attached as shown in the model, making water-tight joints.

This bridge, with spans 520 and 515 feet, was designed by Captain James B. Eads, Chief Engineer, and the superstructure was manufactured by the Keystone Bridge Co., and erected by them, by means of direct guys composed of two lines of main cables of forty-two square inches section passing over towers to anchorages on the shore, and by guys balanced over towers on the piers. The towers stood on hydraulic rams, which by automatic balance gauges were caused to rise and fall to compensate for changes of temperature in the arches and cables.

The arches were built outward simultaneously from the abutments and from each side of the piers, and supported as shown in the photographs on exhibition, taken at successive stages of the work. This is the largest arched bridge in the world. In completeness and nicety of detail, and in accuracy of workmanship, it stands unrivaled.

Weldless Eye-Bars for Chords and Suspension Bars of Bridges.—These bars are made without welds, being upset in moulds by hydraulic pressure and afterwards forged to restore the fibre. Various methods are employed by different parties to make these enlarged heads. By one process the iron is upset with a head larger than is required, and pressed into moulds of the exact form required by pressure applied on the flat surface. By another method, additional plates are laid on the sides of the bar, and this mass is pressed into moulds, and welded by pressure on the flat surface. By another method the heads are forged separately and welded on the bar. Bad welds and distorted fibre result from all these expedients. The Keystone Bridge Company prefer eye-bars, made by their patented method, first described. They have made large quantities similar in width to the exhibit, but of double the thickness. These eye-bars are probably the largest ever manufactured in the United States. They were furnished for the anchorages of the New York and Brooklyn bridge.

Rivetless Columns.—Wrought iron columns, so extensively used in bridges and buildings, have heretofore been made of segments, riveted through projecting flanges; or by diametrical rivets or bolts, combining the several segments. Both of these methods are expensive. The rivetless columns exhibited by the Keystone Bridge Company are made of any required number of bars, rolled with dove-tailed projections, over which fits a rolled cap or batten. This cap slips on loosely, and the column is then passed through rolls, which draw the battens so tight that they can be removed only by splitting them their entire length. These columns have been subjected to tests for compression and transverse strains, and the results have proved that their resistance is fully up to, and generally exceeding, the results given by "Gordon's Formula." The constant, in this formula increased from 36,000 lbs. to 40,000 lbs., more nearly agrees with the result of the test. The battens cannot be removed by sledging. Columns dropped a height of twenty feet across a beam, bent with a regular curve, without starting the battens. The cost of uniting these columns is less than one-half the cost of uniting riveted columns, and, by varying the form of the covering strips, they may be adapted to various pleasing architectural designs."

The Gould Steam Fire Engine.—The *Engineering and Mining Journal*, in its issue of July 29th, commits the singular errors (of carelessness, doubtless) of styling the Gould Steam Fire Engine, (made by B. S. Nichols & Co., Burlington, Vt., and which is a reciprocating piston engine of the most pronounced type), a *rotary* of the same class as the La France and the Rumsey; and of fathering the manufacture upon the Gould Manufacturing Co. of Seneca Falls, N. Y.

Carnegie Bros.' (Union Iron Mills, Pittsburg) exhibit adjoins that of the Edgar Thompson Works, just described. They exhibit special shapes of wrought iron for bridges, etc.; and a section of the rolled wrought iron coupling manufactured by them, and used in connecting the steel tubes of the arches in the great steel bridge at St. Louis.

A Handy Implement.—The cut shows a saw made by Mr. E. M. Boynton, and peculiarly handy for general use. As

will be seen, it has two cutting edges; the one having the common V-tooth, the other having the "Lightning" or M-tooth, for heavier work. This saw may be attached to a long pole and used in pruning; the coarser M-teeth being used for the heavier limbs, and the fine V-teeth for the more slender branches.

Weaver's Combination Vise.—This device is made by the Greenwich Machine Works, Greenwich, N. Y., and is intended for making and sharpening horse-shoe calks, heading bolts, etc. There is one stationary jaw, and one sliding inways, and operated by a cam and foot lever. Each jaw has a pivoted square head, different sides or faces of which may be presented to suit the character of the work; and tapering work may be readily held. The vise will take in a plate or bar for bending; or bolts for heading; another pair of faces (beveled) takes in a horseshoe for giving the heel calks the proper bite, pitch, and set; while the toe calk may be given its proper set at once, between another pair of faces. We regret that we have no cut showing this ingenious and practically useful bench tool, which is exhibited at A. 37, Machinery Hall.

The Edgar Thompson Steel Works makes a handsome display of Bessemer steel rails. A noteworthy item of the exhibit is what is designated as "the longest rail in the world." It is of Bessemer steel, and measures 120 feet in length; it is 62 lbs. to the yard, and weighs 2480 pounds. Besides this, the Company exhibits a number of steel rails of various patterns, polished steel rail sections of the various sizes made by them, etc. Several of the rails are likewise shown twisted cold. The exhibits of the Company may be seen on the south side of the Main Building, between the latter and the Mineral Annex No. 1, and also on south side of the Main Building, adjoining the exhibit of the Keystone Bridge Company, described above.

—In the Mineral Annex, a number of the States have made a very creditable exhibition of their respective products.

Illinois is represented by a number of specimens of her native woods, specimens of building stone and galena.

Wisconsin, in addition to a collection of the rocks and fossils representing the geological character of the State, exhibits enormous masses of galena, limestone, sandstone, fire-brick, etc.

Iowa displays a cabinet showing character, thickness and position of the several rock formations of the State. Besides this, there is also displayed a large exhibit of building stone, and a large pyramid of coal.

Indiana makes a good display of her block coals from various localities; kaolin from Lawrence Co,, sandstones, oil-stones (shoe-rubber stones), marls, clays, cements, lithographic stones, iron ores and rails made therefrom, drain tiles, fire-brick, etc.

Tennessee makes a fine exhibit of her coal and iron ores.

Alabama is represented by a group of products exhibited by the Selma, Rome & Dalton R. R., consisting of coal, iron and slate, found along the line of the road.

Kentucky is well represented in a series of magnificent masses of her native cannel coal, a complete series of her soils, marl, etc., besides iron ores, slags, pig iron, fire-brick, and building stones.

Pennsylvania is represented in the Annex by a number of admirably executed models of various portions of the coal regions of the State, and geological sections of great interest.

Ohio bears off the palm in this department by a magnificent exhibit of her natural products. Attracting the eye of every one entering the Annex, are several enormous pyramids of coal from the Mahoning valley, and arranged about there are fine samples of her famous sandstones, that are perhaps without an equal elsewhere; in addition there are shown iron ores, pig iron, band, hoop, sheet and bar iron, clays and products therefrom. Noteworthy likewise in this exhibit is the lampblack obtained from natural gas.

A Feed-water Heater exhibited in the English Department, has, in connection with a series of vertical pipes, or water tubes, an attachment in the form of a number of scrapers that travel up and down the pipes and prevent the collection of soot upon them. These scrapers are operated from the top of the pipes. The heating of the feed is effected by the waste products of combustion about the system of the pipes. The keeping of the pipes free from soot is claimed to result in a considerable saving of fuel.

The American Kaolin Company of Philadelphia, exhibits in Mineral Annex, No. 2, specimens of its Kaolin, tile, china and paper clay; beside a pyramid of fire-bricks and other manufactured articles.

Chas. W. Spurr exhibits in the Main Building a highly interesting display of combined wood and paper veneer-hangings for walls, hallways, etc., and specimens of remarkably well executed marquetrie work. The headquarters of this industry is in Boston, and Mr. Spurr is its sole representative.

The Vulcanized Fibre Company of Wilmington and New York, have an exhibit of their novel products in Machinery Hall (D. 65), and another in the adjoining Shoe and Leather Building. The first comprises hard and flexible vulcanized fibre goods for general mechanical purposes, including elastic fish-bolt washers, car-box covers and dust guards, gibs and journal bearings, flexible sheet packing, etc. The other comprises a number of specimens of trunks made from the same material.

—In the Mineral Annex, No. 2, Philip Newkumet, of Philadelphia, makes a considerable exhibit of his fire brick, gas retorts, and stove and heater linings.

BIBLIOGRAPHICAL NOTICES.

GEOLOGICAL SURVEY OF NEW JERSEY. Annual Report of the State Geologist, for the year 1875. Trenton, N. J., 1875.

Prof. Cook's annual report of progress is contained in a pamphlet of 41 pp., octavo, accompanied by a map of the State.

The year's work embraces (1) a survey and final report on the fire and potters clay of Middlesex County; a special report and geological map of which district, will shortly be ready for distribution. The clay for fire-brick, pottery, etc., annually dug in this district is worth $1,000,000; and a large part of the raw material is worked-up within the State. The report in question describes in detail, and the map shows the structure and arrangement of the various beds of clay, kaolin, etc., and will doubtless prove of great value in the intelligent development of these important industries.

A second portion of the work consists of the collection of specimens of rocks, ores, minerals, soils, etc., for the proper representation of the State at the Centennial Exhibition, and for the State Cabinet. The visitor to the Exhibition who interests himself in such matters will be able to judge how well this work has been done.

Another chapter details the work accomplished towards the construction of a topographical map of the State. Another details the operations of the commission for the drainage of the Great Meadows of the Pequest, in Warren County, which have been actively prosecuted during the past year. The commissioners for the drainage of the marsh lands on the Passaic and its branches have not yet begun active operations. It appears that there are not less than 295,000 acres of tide marsh within the borders of the State.

The character of the water-supply of cities and towns in various portions of the State, forms another subject of a special chapter; and the report concludes with remarks on the mining industries of the State.

Report of Explorations across the Great Basin of the Territory of Utah, in 1859 By Captain J. H. Simpson, United States Engineers. Washington, 1876.

Report upon the Geographical and Geological Explorations and Surveys west of the 100th meridian, in charge of 1st Lieut. Gen. M. Wheeler, United States Engineers, under the direction of Brig. Gen. A. A. Humphreys, Chief of Engineers, U. S. A. Vol. III. Geology. Washington, 1876.

Report of the Exploration from Santa Fé, New Mexico, to the junction of the Grand and Green Rivers of the Great Colorado of the West in 1859, under the command of Captain J. N. Macomb, United States Engineers. With a Geological Report by Prof. J. S. Newberry, Geologist of the Expedition. Washington, 1876.

The above are valuable contributions to a knowledge of the physical geography, geology and natural history of the regions respectively explored.

IMPORTANT PAPERS, too long to reproduce in our columns.

ON THE FORMS OF TEETH FOR GEAR WHEELS (*Illustrated.*) S. W. Robinson (Prof. Mech. Eng., Illinois Indust. Univ.) in *Van Nostrand*, August.

ON THE THEORY AND CALCULATION OF CONTINUOUS BRIDGES, I. Illustrated. Mansfield Merriman, C. E., in *Van Nostrand*, August.

CERTAIN IMPROVEMENTS IN BLAST HEATING APPARATUS. Illustrated. Jas. E. Mills, in *Van Nostrand*, August.

COAL WASHING IN ILLINOIS. Read by E. D. Meier, M. E., before the Engineers' Club of St. Louis, June 10th. Illustrated. *Eng. News*, iii, 228.

ENDURANCE OF IRON RAILS. Read by W. E. C. Coer (Supt. P. & R. R. R. Rail Mill), at Philadelphia Meeting of Am. Inst. Mining Engineers. In Chicago Railway Review, xiii, 28.

AUSTRALIAN TIN AT THE PHILADELPHIA EXHIBITION. *E. & M. Jour.* xxii, 72.

THE EFFECT OF MANGANESE IN BESSEMER METAL. Read before the Am. Inst. M. E., by August Wendel, Troy. N. Y. *E. & M. Jour.* xxii, 76.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, AUGUST 12, 1876 NO. 6.

Fig. 1

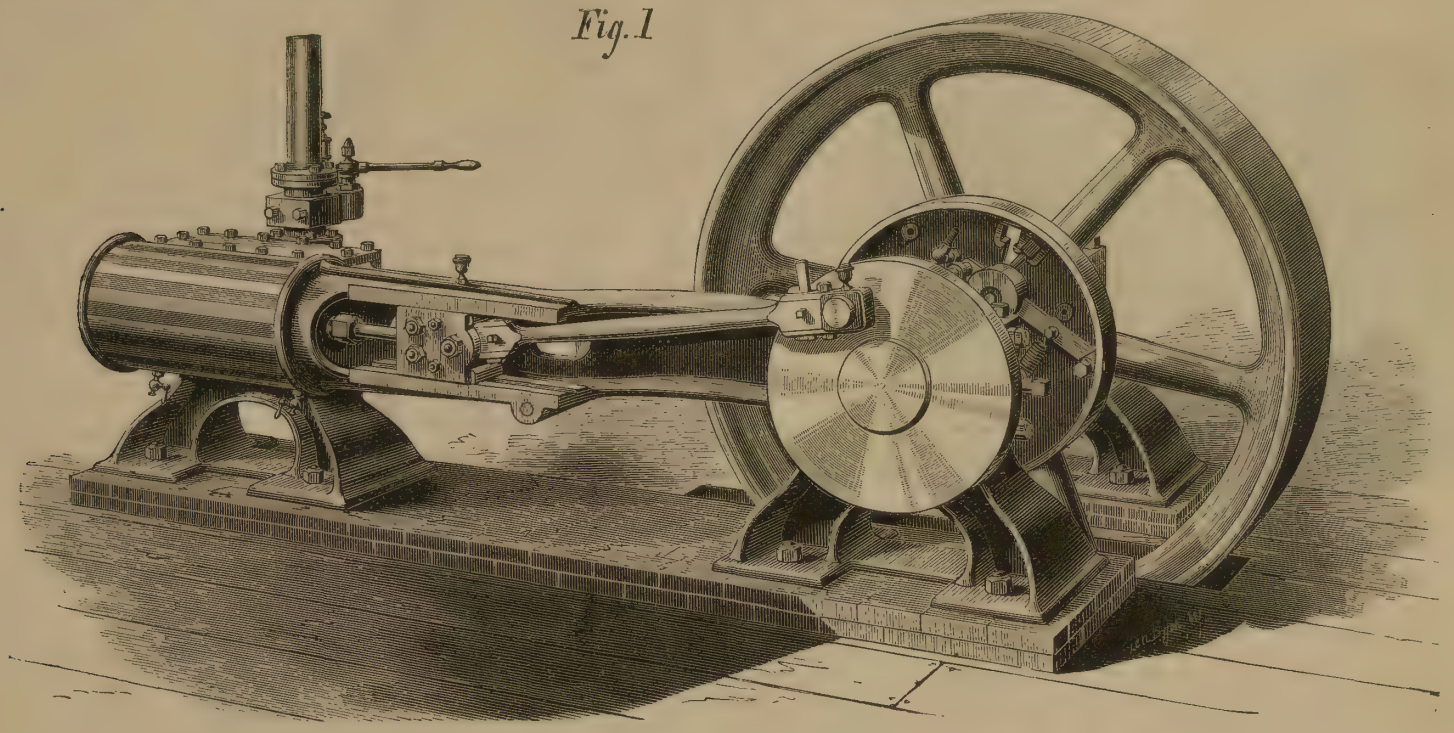
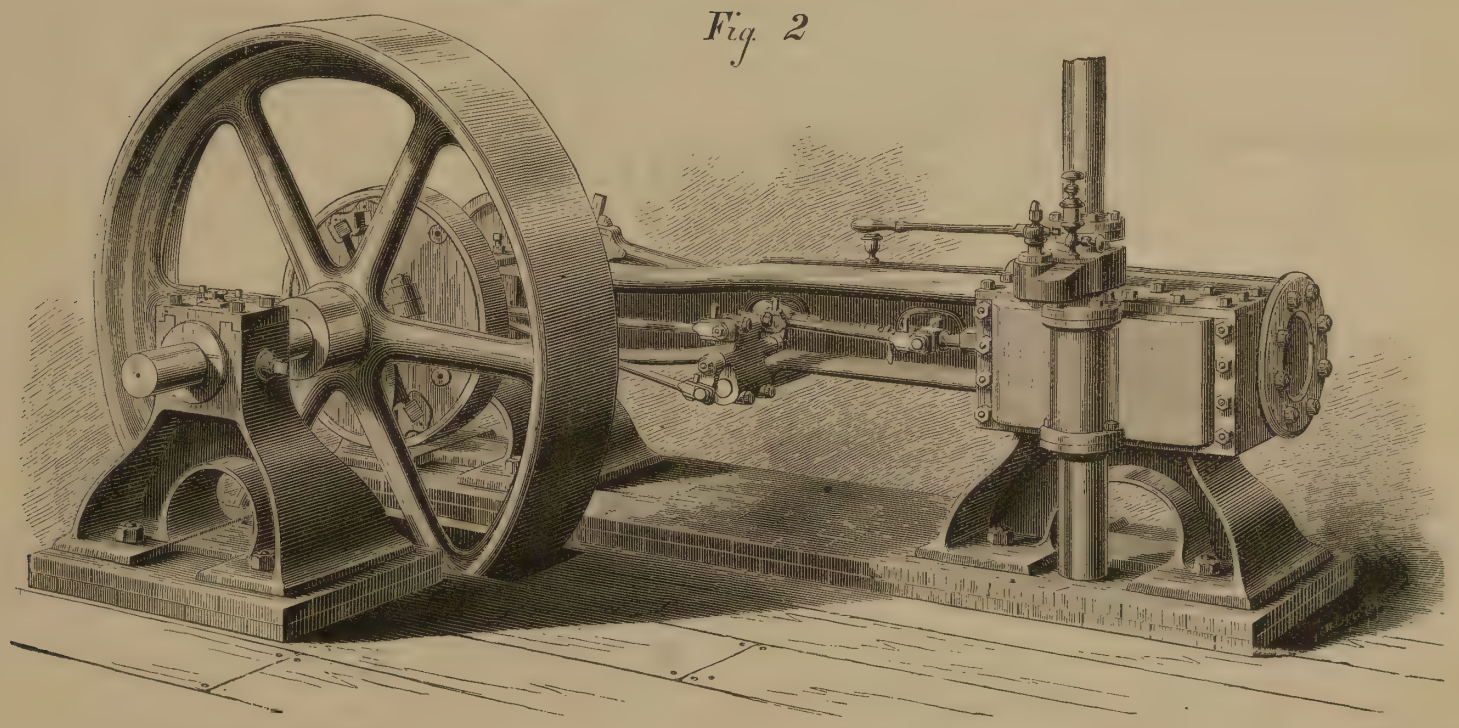


Fig. 2



THE BUCKEYE ENGINE.

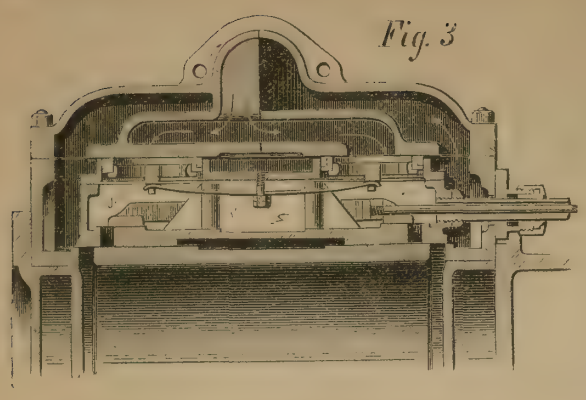
The problem of automatic variable cut-off gears for steam engines has long been solved by what are known as disengagement valve-gears, the Corliss-gear taking the lead among them. But however successful the operation of these gears is as regards the variation and sharpness of the cutting off, the regulation of the speed, etc., yet they possess some rather undesirable features. The mechanism is decidedly complicated and besides in one respect rather unmechanical, the closure of the steam-admission valves being dependent on the action of weights or springs. The fact that they necessarily limit the number of revolutions the engine may be run, renders them unavailable for small sizes requiring high speed.

In the Centennial Exhibition, the tendency is manifested by quite a number of exhibits to evade these difficulties. The double slide-valve—a cut-off valve sliding over the principal valve—is well represented, and it is worth while to study the different means employed for varying the degree of expansion. It is to be observed that with double valves it is not the absolute motion of the cut-off valve, but its motion in relation to that of the principal valve that determines its operation; for the principal valve forms the seat of the cut-off valve. This fact renders the problem of varying the degree of expansion rather intricate.

One of the most interesting engines of this type is the "Thompson Automatic Governor Cut-off Engine," built by the Buckeye Engine Company, Salem, Ohio, (see cuts which not only speaks most creditably for the ingenuity of the designer, but represents also a piece of superior workmanship.

The main valve is moved by a fixed eccentric, through the intervention of a one-armed rocker .(see Fig. 2). Half its length from its fulcrum this rocker carries another double-armed rocker, as shown in the engraving. The lower arm of this second rocker is jointed to the rod of the cut-off eccentric, at a point the hight of which coincides with that of the fulcrum of the main rocker. The upper arm—on the other side of the main rocker—is linked to the rod of the cut-off valve. Now suppose the main eccentric alone was operating and the cut-off eccentric standing still; then the cut-off valve would move along with the main valve, and hence would have no movement on its seat. Again, imagine the cut-off eccentric working and the main eccentric at rest, and the cut-off valve would operate over the stationary main-valve as any other valve would, over a fixed seat when moved by an eccentric. Hence if both eccentrics are rotating simultaneously, the cut-off valve will move in relation to the main-valve as though it was operated by an eccentric over a fixed seat; for the operation of the main eccentric does not affect the relative position of the cut-off valve.

The construction of the valves is a very peculiar one, (see Fig. 3.) The steam is admitted to the cylinder from the interior of the main valve, and is exhausted into the steam chest; the usual order is thus reversed. The main-valve is balanced by two packing-rings through which the steam enters the valve; the cut-off valve is placed in the interior of the main valve, its rod passing through the hollow rod of the latter. The length of the steam-passages is thus reduced to a minimum. and hence the waste of steam due to the clearance is diminished. The clearance of this



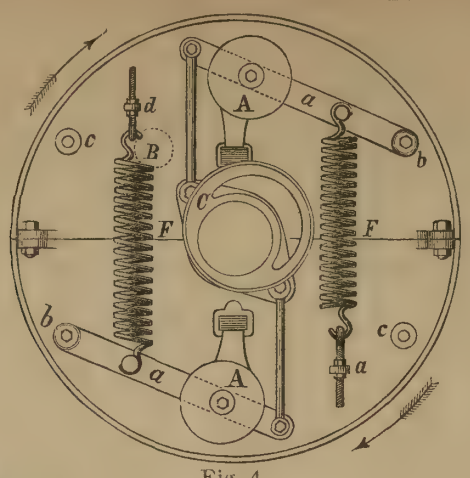


Fig. 4.

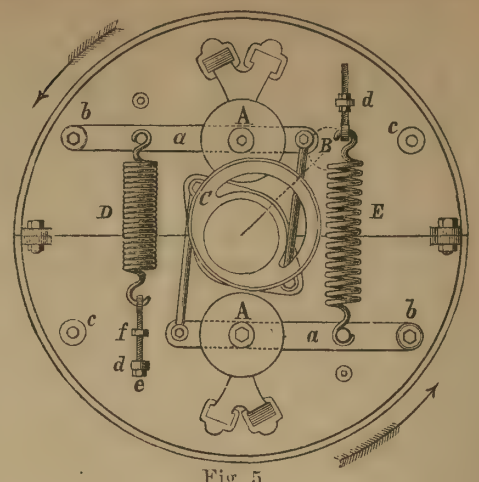


Fig. 5.

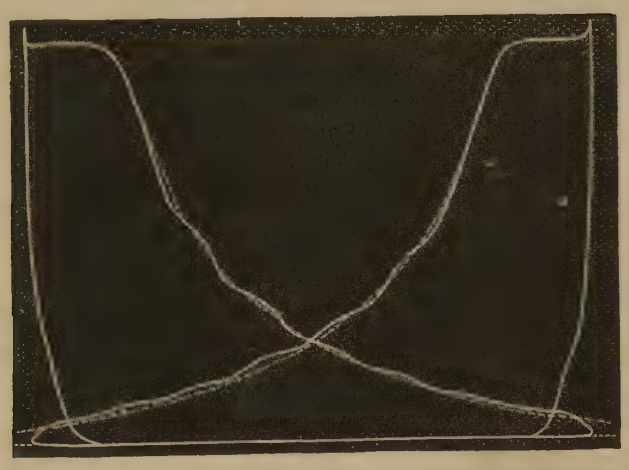


Fig. 6.

engine is a trifle less than one per cent. of its displacement. In order to effect the closure of the steam-passages with the greatest rapidity obtainable at a given throw of the eccentric, the lap of the cut-off valve is negative and about equal to one-half the width of the steam-passages of the main valve.

A variation of expansion is effected by a change of the position of the cut-off eccentric on the main shaft. An advance of the eccentric occasions an advance of the point of cutting off. The adjustment of the eccentric is accomplished by the governor, which is inclosed in a circular case, clamped to the main shaft. It consists of two rotating weights AA (Figs. 4 and 5), that are attached to arms, *a a*, the latter being pulled inward by two strong spiral springs. Two connecting rods connect those arms with the cut-off eccentric, so that a spreading of the arms by the centrifugal force causes a forward rotation of the eccentric, and hence a hastening of the cut-off. Now, since the centrifugal force increases as the radius does for the same angular velocity, it will be seen that this governor will be isochronous if the tension of the springs is so adjusted that it increases exactly as the distance of the weights A from the centre of the shaft. But as governors of this description are apt to "dance or fluctuate," the springs are left a trifle looser; indeed they can easily be so adjusted to make the sensitiveness of the governor suit the character of the machinery to be driven by the engine. The speed will then be slightly above the mean speed when the eccentric is adjusted to the earliest cut-off and a trifle less when at the latest cut-off.

A change of speed, if desired, can be attained by increasing or decreasing the weights A of the governor, or by shifting them along the arms *a a*.

The earliest cut-off admits not quite enough steam to keep the engine running when performing no work, in order that the engine cannot under any circumstances run away. The latest cut-off is at about $\frac{2}{3}$ of the stroke. The follow of steam might easily be carried farther than this point, but no advantage would accrue from this change.

The reaction of the cut-off valve upon the eccentric might be expected to increase the friction so much as to impair the sensitiveness of the governor. This is, however, not the case, for the following reason. The governor exerts its influence upon the production of work in the moment of the cutting off, and immediately before this time there is no pressure on the cut-off valve, and the governor having to overcome but the friction of the stuffing-box and that due to the weight of the cut-off rocker and eccentric, its action is entirely free, its power being in proportion to these slight resistances.

The governor, being attached directly to the main-shaft of the engine, will act more promptly than any other driven by a belt, and besides the dangers connected with a breakage of the governor-belt are altogether absent.

An exceedingly high piston-speed is attainable. The engine on exhibition has a bore of 16″ and a stroke of 32″, and the rate of speed is 96 revolutions per minute, which makes 512 feet mean piston speed. This result is due to the movement of the valves being positive. Notwithstanding this high speed, hitherto attained principally on plain slide-valve engines only—except when the engine has a very long stroke—the engine runs very smooth and noiselessly.

The cut Fig. 6, representing a copy of diagrams taken from the Buckeye Engine, tells its own story. The expansion curve is as good as can be expected. The curve showing the compression is steeper than usual by reason of the clearance these engines possess.

SOLVAY'S AMMONIA—PROCESS FOR MANUFACTURING SODA.

Of the many methods that have been proposed for the direct conversion of common salt into soda, the so-called ammonia process alone, has attained considerable importance. Public attention was first directed to this process by the exhibits of products obtained by it at the Vienna Exhibition in 1873, and in the Report of the Judges upon the chemical industries, the most flattering opinions concerning its value and probable influence in revolutionizing the soda manufacture were expressed. We give in what follows an abstract of a communication of Herr P. Hanrez,* concerning the practical operation of the ammonia process, as illustrated in the establishment of Solvay & Co., at Varangeville-Dombasle, which may be regarded as representing the new industry in its most approved and successful condition.

For a number of years, says Hanrez, the ammonia process for producing soda had attracted the attention of chemists and manufacturers, but the experimental trials that had been made of it were so unsatisfactory as to give rise to the opinion, which was for a considerable period very generally entertained, that the process was incapable of any valuable practical development; so that, although Solvay & Co. had exhibited samples of soda obtained by their process as early as 1867, at the Paris Exposition, the new industry, then just in the incipiency of its development, attracted little attention. At the Vienna Exposition, therefore, it was regarded as a most noteworthy fact, that the production of soda by means of ammonia was no longer a questionable matter in a commercial sense, and that Solvay had succeeded in raising it in the meantime to the rank of an important industry, employing over one hundred workmen, with a yearly production of 90,000 cwt. of soda. Since the year 1873 the works of Solvay & Co. in Belgium and France have been greatly extended, two similar works have been founded in England, and others are in course of establishment at various localities in Europe and America. [The Editor of the *Deutsche Industrie Zeitung* here remarks that, of his knowledge, at least five establishments employing Solvay's process have been founded in Germany, of which, however, only a few have been successful. Of these, however, Hanrez makes no mention.]

The ammonia-soda process is based upon the fact that, when solutions of common salt and bi-carbonate of ammonia are brought together, there results a double decomposition, producing bi-carbonate of soda and sal-ammoniac. The bi-carbonate of soda is decomposed with the aid of heat, by which the simple carbonate is produced. The carbonic acid given off is absorbed and utilized again, and the sal-ammoniac is treated with caustic lime, distilled, and the ammonia converted into the bi-carbonate, to be again utilized. Chloride of calcium remains behind as a by-product.

These reactions are very simple, and easily performed in the laboratory; their industrial utilization, however, is attended with numerous difficulties. The first to appreciate the technical importance of the above described chemical facts, were Messrs. Dyar & Hemming, who, as early as 1838, patented the process in England. They described the chemical details of the ammonia process very correctly and fully; the mechanical details, however, very imperfectly. Delauney, who is named by Schlösing as the inventor of the process, took out a patent in France, somewhat later than the English patent of Dyar & Hemming. Delauney's patent specification is to a large extent a literal translation of that of his predecessors, which makes it probable that he was simply the representative of their invention in France.

Since the occurrence of the above, numerous patents, going over the same ground, have been taken out in France and England, and several of the patentees in question have laid claim to the discovery of the chemical principles therein involved. Even the earliest patent of Solvay, issued in 1861, is based upon the chemical reactions in question. The commercial failure of these earliest investigators explains, perhaps, why the process remained comparatively unknown for so long a time.

Before Solvay's time, Muspratt, Schlösing, Rolland, Gossage, Deacon and others, gave this subject considerable attention; a company in Cheshire erected a manufactory for working the patents of Dyar & Hemming; Deacon, in 1855, made numerous experimental trials with an ammonia process of his own, and with that invented by Gossage; Bowker built an establishment near Leeds; and Muspratt, who first introduced the Leblanc process into England, had undertaken, at great expense, experimental trials of the ammonia process, on the commercial scale, at his works at Newton in Lancashire. In France, the *Société des Salines*, in the year 1854, had introduced at Sommervilliers, near Nancy, a similar process patented by Turck; and in 1855, Schlösing and Rolland founded an ammonia-soda works in Puteaux, which they adandoned in 1858. About the year 1842, likewise, an earnest effort was made to introduce the process in Belgium at an establishment located near Vilvorde.

The above-named were the most noteworthy of the many attempts to render the ammonia-soda process a commercial success. They all failed, however, because of the numerous practical difficulties which the process presents, and because of the imperfection of the apparatus employed.

In the year 1863 Solvay obtained a patent upon his first apparatus. This apparatus he employed in an experimental works near Brussels, and the results which he

*Deutsche Industrie Zeitung, 1876, 252

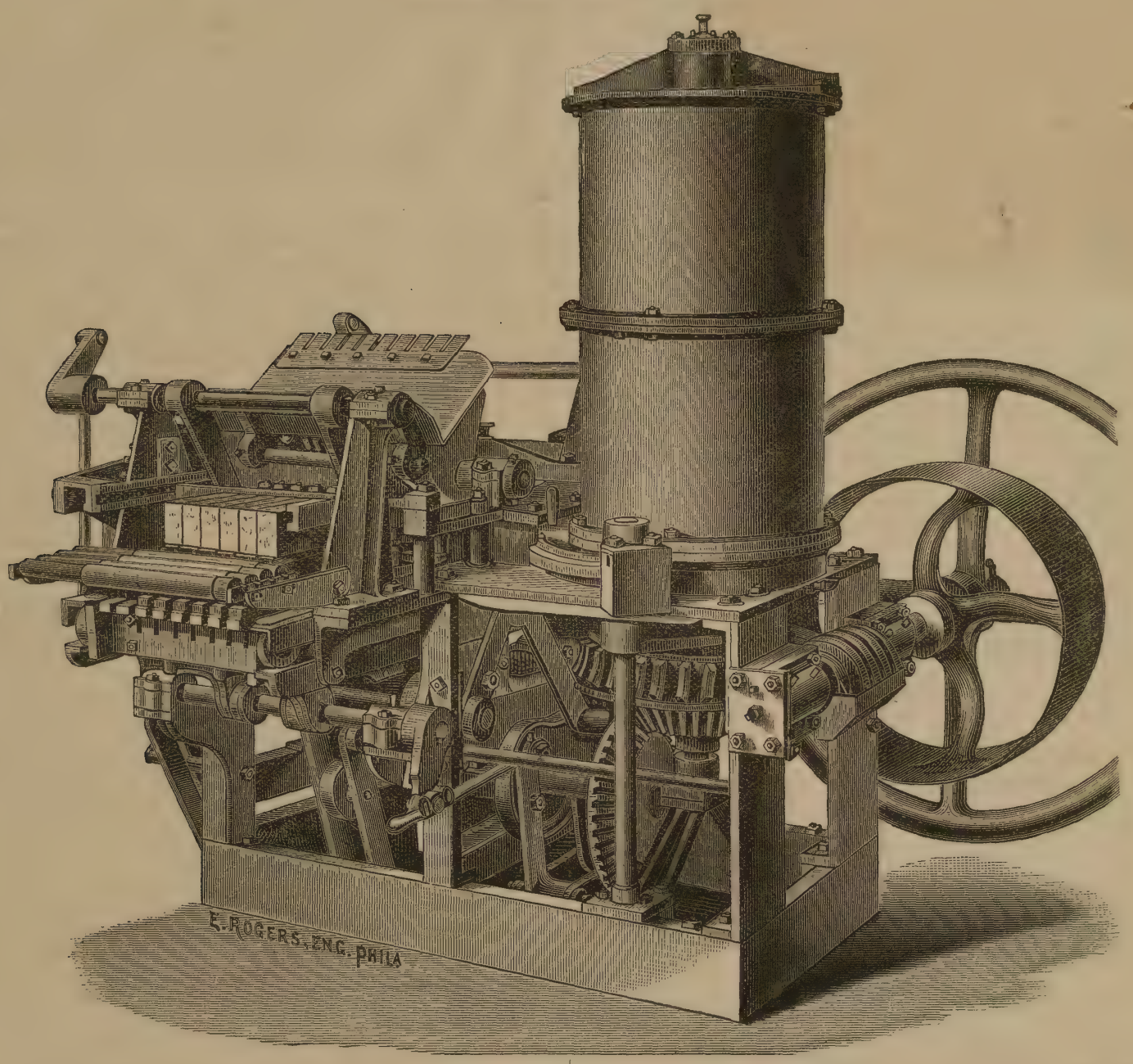
obtained were so satisfactory as to warrant him in building a considerable establishment in Couillet near Charleroi. Before he made a commercial success of his operations, however, he was obliged to overcome numerous difficulties, expend large sums of money and materially modify his apparatus. At the Vienna Exposition, finally, he obtained the first public recognition of his labors in the form of a diploma of honor. The establishment of Solvay & Co., in Couillet, produces yearly, at the present time, 100,000 cwt. of soda, far superior in purity to any soda hitherto put upon the market. The works at Varangeville-Dombasle (France), erected at the site of a considerable rock-salt deposit, has a present production of 160,000 cwt., and before the close of the year will be able to furnish 320,000 cwt. When entirely completed, it will probably be the most important soda works in the world. The two ammonia-soda works in England together produce, yearly, 160,000 cwt., and are being enlarged.

It is premature, perhaps, at this time to speculate upon the possible influence that the development of the Solvay process will exert upon the soda industry. It is, however, safe to affirm that, so long as the chloride of calcium—which is formed as a by-product—cannot be utilized for the manufacture of chlorine, there will be room for the old Leblanc process. It is worthy of remark, however, that Solvay has lately patented the use of magnesia in place of lime in the distillation of the sal-ammoniac. By this substitution he obtains chloride of magnesium (instead of chloride of calcium), which only requires to be heated, to be decomposed, and the regenerated magnesia can be employed indefinitely.

The following analysis of a sample of soda made by the Solvay ammonia process, will give an idea of its extraordinary purity, viz:

Carbonate of soda	99·438 per cent.
Chloride of sodium	0·21 "
Silicic acid and carbon	0·04 "
Oxide of iron	0·001 "
Alumina	trace.
Carbonate of lime	trace.
Water	0·31
	100·00 per cent.

Finally, it is worthy of remark that the production on the commercial scale of almost chemically pure soda, will render possible the material improvement of the product of manufactures employing soda. This is especially true of the glass manufacture. The small proportion of iron is especially worthy of remark. W.



THE "PEERLESS" BRICK MACHINE.

The frame-work and bed-plate of this machine are constructed of iron, and occupy a space of about eight feet square. There is an upright cylinder or pug-mill two feet in diameter and four feet high. This cylinder is cast in sections and bolted together, and has a vertical shaft passing through its centre, provided with a series of knives for cutting and tempering the clay, and forcing or feeding it downward to and below a segmental false bottom secured in the lower part thereof. In the space between the false bottom and the bottom of the pug-mill works a pusher attached to the shaft, the front of the said pusher being made convex or curved. This pusher forces the clay from the pug-mill through a die or mouth-piece into moulds, and acts in connection with a pivoted stop, which also works under the false bottom. As the clay is forced by the pusher under the false bottom the stop prevents it from going around, and causes it to pass through the die or mouth-piece into the moulds. By the use of the pusher and stop the clay is forced direct from the pug-mill, obviating the use of any other machinery for that purpose. These parts, also, from their regulation and motion, produce a safety-valve at the proper time, enabling any excess of clay fed down by the knives in the pug-mill to be returned for the next charge, thereby avoiding any undue pressure in the moulds.

The moulds are attached to each end of a carriage, which has a reciprocating motion, and stops with each set of moulds at the proper time immediately in front of and flush with the mouth of the die. These moulds have grooves or cuts, through which pass knives placed upon a revolving shaft above, separating and dividing the clay into bricks. The outer end of the moulds has a solid abutment against which the clay is forced, in order to press out any flaw, crack or imperfection. After the knives have cut the clay, the carriage is moved, bringing the other set of moulds in front of the die, and while this set is being filled, the others are discharged. The bricks are discharged by the raising of the bottom of the moulds (which are styled followers) on a level with the sides. A sweep or push-bar then removes them on to boards or a stationary table, from which they are taken by a boy and placed on drying cars or barrows. This operation is the same alternately at each end of the machine.

All the motions of the machine are positive and regular, the only belting required being that necessary to transmit the power from the engine. An engine of 20-horse power is sufficient for one machine.

In many machines using a pug-mill for tempering purposes, there has been a failure to obtain regularity of feeding. This difficulty is claimed to be overcome in the "Peerless" by the use of the safety-valve previously described, thus securing all the advantages of manufacturing bricks from thoroughly tempered clay.

The clay may be dug in winter and exposed to the action of the weather, as is generally done in making bricks by hand, or may be taken direct from the bank. A sufficient quantity of water is conducted to the clay in the pug-mill to assist in thoroughly tempering it, before it is forced into the moulds.

The bricks when discharged from the moulds are compact, and of such consistency as to be handled without marking or injury.

In estimating the cost of making bricks by this machine (which is less than one-

half than by the old method,) it is only necessary to say that the only labor required is in bringing the clay to the machine and taking the bricks therefrom.

Where drying cars are used, the bricks are placed direct thereon at the machine, and are not handled until delivered at the kiln; so that the expense of handling is very greatly diminished.

The makers claim that the bricks made by this machine are "perfect bricks," and will bear the closest examination; that they may be cut the same as those made by hand, and will in appearance compare favorably with the justly celebrated Philadelphia and Baltimore bricks; also, that they are admirably adapted for all building purposes, having good angles and being of uniform size.

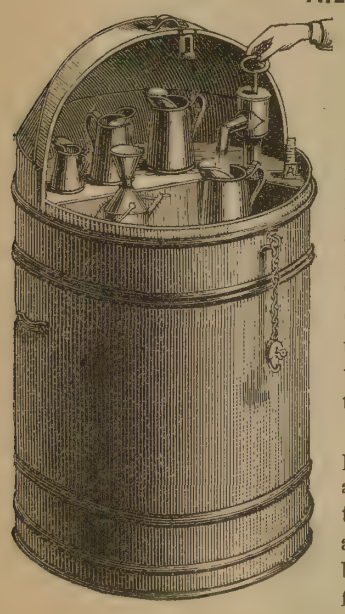
The builders claim that for simplicity of construction, durability, strength, regular movement, and non-liability of derangement of parts, this machine is "Peerless."

They recommend, in connection with this machine, the use of crushing rollers, by means of which all lumps of clay and small stones are pulverized, and larger stones are thrown out.

The price of a machine of a capacity of 20,000 bricks per day (and weighing about four tons,) is $3,500, exclusive of crushing rollers. Machines of large size and capacity, ranging from 25,000 to 35,000 bricks per day, are built to order.

For all information regarding machines, rights, etc., the reader may apply to or address Jos. Wood, Jr., N. E. corner Fifth and Chestnut Streets, this city. The machine itself may be seen in operation at the works of the Peerless Brick Company, Old York Road and Nicetown Lane, Philadelphia.

THE PERFECTION OIL TANK.



Neatness in the shop is gradually becoming not merely a commendable, but a *necessary* virtue. Economy has always received the meed of praise, emanating from the "heart of hearts"—the pocket. Where neatness and economy go hand in hand, the affiliation is not gratifying. It is now not the exception, but the rule, to see well-kept engine rooms, free from litter, grease, or dust; bright brasses glinting with the light reflected from well-polished working parts; and a hard, dry, clean floor showing no signs of grease and grime. One of the aids in this desirable reform is the introduction of oil-tanks permitting the filling of cans or measures, with accuracy and neatness; the overflow, should there be any, returning to the tank.

The "Perfection Oil Tank," shown in the accompaning cut, is one of the most commendable of these appliances. The cut requires little explanation, and the device should commend itself to popular use and approval. It will be seen, the tank is closed tightly by the cover, preventing unpleasant odor, and danger from fire. Measures and cans are filled in the drip-pan, and the overflow runs back to the tank below. The bonnet on cover, when thrown back, does not project beyond the edge of the tank. A shelf for the storage of utensils is arranged in the rear of the drip-pan. The pump is removed for filling the tank, and is independent of the drip-pan, which can also be removed. There is a gauge rod to indicate the amount of oil in the tank, and to detect shortages in the barrel. The tank can be securely locked, and there is a stop-cock attached to the pump, for filling oilers.

THE MECHANICAL ACTION OF LIGHT.

A Lecture delivered at the Royal Institution, London.

BY W. CROOKES, F. R. S.

VI.

Having thus explained the working of the torsion balance I will proceed to the actual experiment. On the central mirror I throw a ray from the electric light, and the beam reflected on a particular spot of the ceiling will represent zero. The graduated circle, J, of the instrument also stands at zero, and the counter which I fasten on at the end, L, stands at O. The position of the spot of light reflected from the little concave mirror being noted, the torsion balance enables me to estimate the pressure or weight of a beam of light to a surprising degree of exactness. I lift up my little iron weight by means of a magnet (for working in a vacuum I am restricted in the means of manipulating), and drop it in the centre of the pith; it knocks the scale-pan down, as if I had placed a pound weight upon an ordinary balance, and the index ray of light has flown far from the zero-point on the ceiling. I now put torsion on the fibre to bring the beam again into equilibrium. The index-ray is moving slowly back again. At last it is at zero, and on looking at the circle and counter I see that I have had to make 27 complete revolutions and 301 degrees, or $27\times360^\circ+301^\circ=10{,}021^\circ$, before the force of torsion would balance the 1-100th of a grain.

I now remove the weight fram the pith-pan of my balance, and liberate the glass thread from torsion by twisting it back again. Now the spot of light on the ceiling is at zero, and the counter and index are again at O.

Having thus obtained the value of the 1-100th of a grain in torsion degrees, I will get the same for the radiation from a candle. I place a lighted candle exactly six inches from the blackened surface, and on removing the screen the pith scale-pan falls down, and the index-ray again flies across the ceiling. I now turn the torsion handle, and in much less time than in the former case the ray is brought back to zero. On looking at the counter I find it registers four revolutions, and the index points to 188 degrees, making altogether $360^\circ\times4+188=1628^\circ$, through which the torsion fibre has to be twisted to balance the light of the candle.

It is an easy calculation to convert this into parts of a grain weight; 10,021 torsion degrees representing 0·01 grain, 1628 torsion degrees represent 0·001624 grain.

$$10{,}021^\circ : 0{\cdot}01 \text{ grain} :: 1628^\circ : 0{\cdot}001624 \text{ grain}.$$

The radiation of a candle six inches off, therefore, weighs or presses the two square inches of blackened pith with a weight of 0·001624 grain. In my own laboratory, working with this torsion balance, I found that a candle six inches off gave a pressure of 0·001772 grain. The difference is only 0·000148 grain, and is fairly within the allowable limits of a lecture experiment. But this balance is capable of weighing to far greater accuracy than that. You have seen that a torsion of 10,021° balanced the hundredth of a grain. If I give the fibre one degree more twist the weight is overbalanced, as shown by the movement of the index-ray on the ceiling. Now one degree of torsion is about the 1-10,000th part of the whole torsion required by the 1-100th grain. It represents therefore the 1-10,000th part of the 1-100th, or the millionth part of a grain.

Divide a grain weight into a million parts, place one of them on the pan of the balance, and the beam will be instantly depressed!

Weighed in this balance, the mechanical force of a candle twelve inches off was found to be 0·000444 grain; of a candle six inches off, 0·001772 grain. At half the distance the weight of radiation should be four times, or 0·001776 grain; the difference between theory and experiment being only four-millionths of a grain is a sufficient proof that the indications of this instrument, like those of the apparatus previously described, follow the law of inverse squares. An examination of the differences between the separate observations and the mean shows that my estimate of the sensitiveness of this balance is not excessive, and that in practice it will safely indicate the millionth of a grain.

I have only had one opportunity of getting an obversation of the weight of sunlight: it was taken on December 13th, but the sun was so obscured by thin clouds and haze that it was only equal to 10.2 candles 6 inches off. Calculating from this datum, it is seen that the pressure of sunshine is 2.3 tons per square mile.

But however fair an equivalent ten candles may be for a London sun in December, a midsummer sun in a cloudless sky has a very different value. Authorities differ as to its exact equivalent, but I under-estimate it at 1000 candles 12 inches off.

Let us see what pressure this will give:—A candle 12 inches off, acting on two square inches of surface, was found equal to 0.000444 grain; the sun equalling 1000 candles, therefore gives a pressure of 0.444000 grain; that is equal to about 32 grains per square foot, to 2 cwts. per acre, 57 tons per square mile, or nearly three thousand million tons on the exposed surface of the globe—sufficient to knock the earth out of its orbit if it came upon it suddenly.

It may be said that a force like this must alter our ordinary ideas of gravitation; but it must be remembered that we only know the force of gravity as between bodies such as they actually exist, and we do not know what this force would be if the temperatures of the gravitating masses were to undergo a change. If the sun is gradually cooling, possibly its attractive force is increasing, but the rate will be so slow that it will probably not be detected by our present means of research.

Whilst showing this experiment I wish to have it distinctly understood that I do not attach the least importance to the actual numerical results. I simply wish to show you the marvellous sensitiveness of the apparatus with which I am accustomed to work. I may, indeed, say that I know these rough estimates to be incorrect. It must be remembered that our earth is not a lamp-blacked body enclosed in a glass case, nor is its shape such as to give the maximum of surface with the minimum of weight. The solar forces which perpetually pour on it are not simply absorbed and degraded into radiant heat, but are transformed into the various forms of motion we see around us, and into the countless forms of vegetal, animal, and human activity. The earth, it is true, is poised in vacuous space, but it is surrounded by a cushion of air; and, knowing how strongly a little air stops the movement of repulsion, it is easy to conceive that the sun's radiation through this atmospheric layer may not produce any important amount of repulsion. It is true the upper surface of our atmosphere must present a very cold front, and this might suffer repulsion by the sun; but I have said enough to show how utterly in the dark we are as to the cosmical bearings of this action of radiation, and further speculation would be but waste of time.

It may be of interest to compare these experimental results with a calculation made in 1873, before any knowledge of these facts had been made public.

Prof. Clerk Maxwell, in his *Electricity and Magnetism*, vol. ii., p. 391, writes as follows:—"The mean energy in one cubic foot of sunlight is about 0.0000000882 of a foot-pound, and the mean pressure on a square foot is 0.0000000882 of a pound weight. A flat body exposed to sunlight would experience this pressure on its illuminated side only, and would therefore be repelled from the side on which the light falls."

Calculating out, this gives the pressure of sunlight equal to about 2½ lbs. per square mile. Between the 2½ lbs. deduced from calculation and the 57 tons obtained from experiment the difference is great; but not greater than is often the case between theory and experiment.

In conclusion, I beg to call especial attention to one not unimportant lesson which may be gathered from this discovery. It will be at once seen that the whole springs from the investigation of an anomaly. Such a result is by no means singular. Anomalies may be regarded as the finger-posts along the high road of research, pointing to the by-ways which lead to further discoveries. As scientific men are well aware, our way of accounting for any given phenomenon is not alway perfect. Some point is perhaps taken for granted, some peculiar circumstance is overlooked. Or else our explanation agrees with the facts not perfectly, but merely in an approximate manner, leaving a something still to be accounted for. Now these residual phenomena, these very anomalies, may become the guides to new and important revelations.

In the course of my research anomalies have sprung up in every direction. I have felt like a traveler navigating some mighty river in an unexplored continent. I have seen to the right and the left other channels opening out, all claiming investigation, and promising rich rewards of discovery for the explorer who shall trace them to their source. Time has not allowed me to undertake the whole of a task so vast and so manifold. I have felt compelled to follow out, as far as lay in my power, my original idea, passing over reluctantly the collateral questions springing up on either hand. To these I must now invite the attention of my fellow-workers in Science. There is ample room for many inquirers.

Nor must we forget that the more rigidly we scrutinise our received theories, our routine explanations, and interpretations of Nature, and the more frankly we admit their shortcomings, the greater will be our ultimate reward. In the practical world fortunes have been realized from the careful examination of what has been ignorantly thrown aside as refuse; no less, in the sphere of Science, are reputations to be made by the patient investigation of anomalies.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The San Fernando Tunnel through the San Fernando Mountains, Southern Pacific R. R., Cal., is the largest on the Pacific coast. It is 6,966 feet long, and has been built in less than two years, under great difficulties and apprehensions. The great obstacle has been the character of the rock, necessitating heavy timber supports. There were fears of encountering reservoirs of petroleum or natural gas. [Abr. from *Railway Review*, xiii, 33.]

An Improved Lifting Machine has a vertical lifting bar toothed on both sides, and raised by gear wheels on shafts which are journalled on a supporting frame, and which have ratchets and pawls, and cranks. The frame is mounted on rollers. Patented June 13, 1876, by August Ficht, Bella Sylva, Wyoming Co., Pa.

Compressed Air as a Street Car Motor.—Mékarski, of Paris, uses compressed air and steam; a regulating diaphragm insuring constant equality of pressure beyond the throttle. Starting with a pressure of 375 lbs., there was used on an ordinary street-car, less than 11 cubic feet of air per mile.

A New Compound Engine Jack permits of raising a locomotive vertically and then moving it laterally to place it upon the rails. There are two ordinary screw-jacks having a common base bearing on rollers in a cast-iron box open at one end; this base being movable by a horizontal screw. Patented June 6th, 1876; W. C. Taylor, R. Vampill, Mullins, S. C.

The Hoosac Tunnel.—The first passenger train passed through the tunnel July 8, 1875. The road was then formally opened, but so much work remained to be done that it was not ready for actual use until July 17. During the past year the tunnel has been enlarged and arched, and the road from Greenfield to North Adams rebuilt, making it very substantial. Trains have only run at night, that the work might not be interrupted. An average of one hundred cars of Western freight has been carried eastward daily, but a single mixed train has taken all the passengers between Greenfield and North Adams without reference to connections with other roads. The tunnel and the picturesque Deerfield Valley will attract many summer visitors, and it will daily become more of a thoroughfare. Passenger trains run through the tunnel in 18 minutes, while 30 are allowed for freight. A telegraph station is established at each entrance, and but one train is permitted in at a time. When the business of the road shall require it, another telegraph operator will be stationed at central shaft, and two trains allowed to pass through at the same time. Three passenger trains each way will be run for the present between Boston and Troy every day except Sunday.

The central shaft, which was built at an expense of upwards of a million dollars and twenty or more lives, was originally intended as a third point where the work of excavation could be carried on and afterward serve as an immense chimney, through which the smoke and bad air of the tunnel would be taken off. The shaft itself was only completed a few years before it was overtaken by the work from the western entrance of the tunnel, so the temporary advantage it gave cannot be said to be in proportion to its cost. Experience has proved that the rush of air occasioned by the speed of trains affords sufficient ventilation, and that the shaft was an actual disadvantage. It has therefore been entirely closed near the surface of the mountain.

Considerable work still remains to be done between Shelburne Falls and Bardwell's Ferry, and at various points along the route, and the road will be entirely out of the hands of the contractors before winter. The whole cost of the road from Greenfield to the State line on the west, including the tunnel (44 miles) is, according to the lowest estimate, $15,124,000. [*Railway Review*, xiii, 35.]

The Interior Sea in Algeria.—At the last reunion of the Academy of Sciences, Mons. de Lesseps presented the summary report of Capt. Roudaire upon the establishment of an interior sea in the African desert.

"We have reason," says M. de Lesseps, "to be satisfied with the results obtained by our compatriot *savant*; he is henceforth sure that there can be established a sea of from 25 to 40 meters in depth, and which shall cover an area of 16,000 kilom. (6,200 sq. miles) with a length of 400 kilom. (250 miles) from east to west. In applying to the works for executing the new marine lake, the mean cost of the work in hand in Egypt, (0 fr. 95 centimes, [= 18 cts.] per cubic meter of sand) the cost of the enterprise will hardly exceed 40,000,000 fr. ($16,000,000). The revenue of the fisheries would represent, alone, an enormous interest on the capital expended; since we see, in Egypt, the fisheries of the salt lakes produce 1,500,000 fr. ($300,000) revenue. In this great submersion of the desert, not a single oasis will be destroyed; Capt. Roudaire is assured that the cultivated points of the desert are, without exception, 20 meters above the sea-level. Capt. Roudaire is present at the meeting, and I am happy to express before him the high opinion which we have of his courage, his perseverance, and his disinterestedness." [Trans. from *Revue Industrielle*, vii, 289.]

Progress of the Railway Tunnel under the Hudson River, New York City.—In April, 1875, we gave the details and drawings of the Hudson River Tunnel, projected by Mr. D. C. Haskin, of this city, and designed to establish direct railway communication between New York city and Jersey city. The work was begun by commencing a vertical shaft of brick masonry, 30 feet in diameter and four feet thick, at the junction of Jersey avenue and 15th street, on the Jersey side, between the present depots of the Erie and Delaware and Lackawanna railways. After the shaft had reached a depth of about 20 feet, the Delaware and Lackawanna Company commenced legal proceedings to stop the work, obtained injunctions, etc., and, by resort to various legal quibbles, managed to delay the enterprise until the present time. The Hudson River Tunnel Company has, however, come off finally victorious, the injunctions are removed, and the construction is now to proceed with. It is understood that the wealthy Senator Jones, of Nevada, furnishes the capital, the estimated cost being ten to fifteen millions of dollars. The shaft on the Jersey side is to be carried down 65 feet. The horizontal tunnel under the river will then be commenced. The latter is to be 26 feet in diameter. [*Sci. Am.* xxxv, 97,]

Annealing and Guaranteeing Car Wheels.—"Louisville, Ky. To the editor of the *Railroad Gazette:* Thinking a few items regarding the manufacture of car wheels in this latitude might be of interest, I will venture to send you a description of the method employed here in annealing wheels, and also the guarantee which the Louisville Car-Wheel and Railway Supply Company gives of the wheels furnished to railroads.

Our method of annealing wheels has at least the merit of originality. As is well known to any one at all conversant with the subject, the great trouble in cooling a wheel arises from the fact that the tread and sides being thinner, cool more quickly and "set," leaving the heavier hub to cool more slowly, and frequently by its own contraction to split a 500-lb. wheel as though it were glass. Several expedients have been adopted, of which the following is our own: We group our pits in groups of three. Equidistant from the three pits (and consequently in the middle) we have a small flue connecting with the bottoms of the three pits. The wheels being pitted with their hubs resting one upon the other leave a flue through the centres of the wheels. Through this the hot air finds its way to the top, making room for the cooler air from the flue, establishing a draught and thus cooling the hubs with sufficient rapidity.

Our guarantee is also original, and may be interesting. We give a "minimum guarantee" of every wheel we make to run at least 50,000 miles, and we do it as follows:

Supposing a wheel guaranteed by us to make 50,000 miles makes only 40,000. It is of course worth to the railroad company only 4-5 of the original price, and the difference is refunded them, *less the value of the wheel as it stands for scrap.* To such a fine point does this reduce it, that our reclamation on a wheel frequently is less than a dollar, and in two instances 6 and 9 cents respectively. W. G."

Locomotive Trials.—Under this head a correspondent of *Van Nostrand's Engineering Magazine* for August, says:

"Now that the railroads throughout the country are reducing their tariffs on freight, it becomes a matter of some importance to know what particular construction of locomotive engine will do the required work, and with the least expense to the corporation. There seems to be a difference of opinion existing among master mechanics as to the comparative merits of the engines known as Moguls, constructed with three pair of drivers connected, and pony truck, and the ordinary two pair of drivers and single truck. Without going into any lengthy detail as to either, I wish to lay before you some facts which may interest many readers of the magazine. The officers of the Boston & Albany Railroad have given this matter their attention, and have for the five days, as specified in the table below, thoroughly tested the economy and relative merits of the two engines. The trial was from Albany to Pittsfield and return, a distance of 101 miles, between Mogul engine 'Brown' No. 230, built for the company by the Rhode Island Locomotive Works, and the 'Virginia' No. 11, built at the shops of the company at Springfield, by Wilson Eddy, Master Mechanic, each engine pulling the same number of loaded cars; and as you will see below, demonstrated conclusively the great economy of the 'Virginia' over the Mogul engine 'Brown,' and a saving to the corporation in five days of $24.24, or in the ratio of $1,518.05 per year on fuel. This certainly, so far as this road goes, does not speak favorably for the Mogul engines. What the tests are upon other roads I have yet to learn."

Performance of Engines at E. Albany.	Brown 230. Coal. lbs.	Virginia 11. Coal. lbs.	Difference. Coal. lbs.
June 16, 1876	6,260	4,800	1,460
" 17, "	5,930	4,964	966
" 19, "	6,620	4,900	1,720
" 20, "	5,980	4,780	1,200
" 21, "	6,060	4,480	1,580
	30,850	23,924	6,926
Value at $7 per ton	$107 97	$83 73	$24 24
Cost per mile	21 38	16 58	4 80
Cost per trip	21 59	16 74	4 85
Cost for 313 trips (year)	6,759 67	5,239 62	1,518 05

The *Railroad Gazette*, in quoting the above, says: "Fuller information about these experiments would be very interesting. What were the dimensions and weight of the engines, especially the weight on the driving wheels and the extent of grate and heating surface? What were the loads hauled, and were both engines worked up to their maximum capacity?"

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Antiseptic Qualities of Benzoic Acid.—Trimble has published the results of a series of experiments upon benzoic acid, in which the antiseptic properties of the substance named are compared with those of salicylic acid.

The results of the author are shown in condensed form in the following table:—

	One part of Salicylic Acid.	One part of Benzoic Acid.
To 2000 parts of Infus. Buchu.	Spoiled in 8 days.	Remained unaltered after 60 days.
4000 parts of Infus. Buchu.	Spoiled in 4 days.	Spoiled in 16 days.
8000 parts of Infus. Buchu.	.....	Spoiled in 5 days.
2000 parts of Infus. Colombo.	Spoiled in 16 days.	Cloudy, but no change of color in 16 days.
1000 parts Sol. of Albumen (1 in 16 water.)	Spoiled in 19 days.	Unaltered after 30 days.
4000 Sol. of Albumen (1 in 16 water)	Spoiled in 10 days.	Spoiled in 19 days.

In the case of the infusions above referred to, it should be remarked that without the addition of an antiseptic they would have commenced to decompose within 24 hours, and the solution of albumen within 48 hours.

The author's further experiments relate to the trial of the anti-fermentative qualities of benzoic acid, which were found to be not inferior to these of salicylic acid.

His main conclusions are:—

(1) Benzoic acid, sublimed or artificial, possesses valuable antiseptic qualities.

(2) It has the power to arrest decomposition.

(3) As an antiseptic it is superior, in many if not in all cases, to salicylic acid. It has also the advantages of being obtained in a state of purity, and of having a lower commercial value. [*Am. Jour. Pharm.* iv: vi, 347.]

It is to be regretted that the author did not extend his interesting investigation to the determination of the comparative value of benzoic acid in medicine and surgery, in which fields of application, salicylic acid, from its entirely harmless character, and absence of offensive taste and smell, has been found to be eminently valuable.

New Colors.—Rosenstiehl has obtained a coloring matter in yellow metallic lamellæ, by treating dry artificial alizarin with nitrous acid. With alumina it dyes yellow, and with iron mordants a red violet, both of which colors can be brightened with boiling soap lyes. It dyes best in distilled water, or with addition of acetate of lime. The author considers it to be nitro-alizarin.

—M. R. Wagner states that if sulphate of copper is added to an aqueous solution of resorcin, and then enough ammonia is added to redissolve the precipitate first formed, a deep black liquid is obtained, which dyes wool and silk black, and which may possibly be used as an ink. [Notes from foreign sources—*Chem. News.*]

—The copper mines of Newfoundland are being developed with great success, and considerable deposits of lead are said to have been lately discovered.

New Domestic Ice Machine.—*Les Mondes* shows Toselli's apparatus, which has a cylindrical case, swung on trunnions, and with a cover at each end. Within this fits a nest or set of cylinders, secured between heads, and the diameters regularly decreasing. In these is placed in graduated quantities, the water to be frozen. The space between these and the outer case is filled with a mixture of equal weights of nitrate of ammonia and water; rotation for five minutes produces a series of nests or tubes of ice, which can be removed, and fitted together to form a solid block. *Les Mondes* gives no statement of the cost of production.

Headache from Eye-Strain.—Dr. S. Weir Mitchell of Philadelphia, communicates to the *Am. Jour. Med. Science* the following propositions:

1. That there are many headaches which are due indirectly to disorders of the refractive or accommodative apparatus of the eyes.

2. That in these instances the brain symptom is often the most prominent, and sometimes the sole prominent symptom of the eye troubles, so that while there may be no pain or sense of fatigue in the eye, the strain with which it is used may be interpreted solely by occipital or frontal headache.

3. That the long continuance of eye trouble may be the unsuspected source of insomnia, vertigo, nausea, and general failure of the health.

4. That in many cases the eye trouble becomes suddenly mischievous, owing to some failure of the general health, or to increased sensitiveness of the brain from moral or mental causes.

The form of head-pain caused by eye troubles is rarely of the nature of megrim, and, as it soon disappears when the eyes are corrected, is lacking, happily, in the obstinacy of that distressing malady.

—Biermann & Clodius, of Hannover, manufacture a variety of German silver in which the nickel of the usual composition is replaced by manganese. Its composition is 72·25 per cent. copper, 16·57 manganese, 8·75 zinc, and 2·43 iron. A specimen of the above lay 40 days in water without showing any alteration. It possesses a somewhat yellowish tint, and takes on a fine polish. [*Berg. u. Hüttenm. Zeit.* xxxv, 239.]

—At Rouen the chloride of calcium, which is a waste product of the pyroligneous acid manufacture, is used in the watering of streets, &c., and, it is said, with the best results. In virtue of its hygrometric quality, the streets retain the moisture for a week without replenishing the supply. [*Nature* xiv, 244.]

MISCELLANEOUS.

Turkish Baths are injurious to apoplectic persons or those suffering from fatty degeneration of the heart. [Prof. Thos. Bond, London.]

Oil of Sassafras is said by Dr. A. F. W. Lyle, in the Cincinnati *Lancet & Observer*, to counteract the evil effects of tobacco.

A New Ozone Machine generates the ozone in separate vertical tubes containing phosphorus sticks, and with an adjustable water-level regulating the consumption of the phosphorus. Above the generating chamber is a double chamber containing an alkali as a purifier. Patented Feb. 18, 1876; F. W. Bartlett, Buffalo, N. Y.

Aërial Navigation.—Mons. Rablat is now exhibiting, at the Casino Cadet, a model of an aerial vessel designed to operate without the aid of a balloon, or the use of a gas lighter than air.

The inventor has at each side of his vessel three pairs of wings which are actuated by an engine in the hull. The wings are elevated and depressed alternately; made of a light rattan framework and of bands of cloth, they yield to the pressure of the air in the upward movement, and press upon it on the down stroke, reproducing as faithfully as possible the action of the bird's wing. The simple and strong construction of this aerial vessel merits the attention of lovers of aërostation. As to the possibility of elevating and manœuvring in the air such a system, we decline to pronounce, being ignorant of the yet unknown motor which shall give to wings stretching over 12 meters in length an indeterminate number of oscillations per minute. [Trans. from *Revue Industrielle*, vii, 289.]

Russian Prize Essay on Engine and Boiler Management.—The Russian Technical Society offers a prize for the best essay on the management of engines and boilers, drawn up in Russian, in a popular style, for the instruction of mechanics, stokers, engine-drivers, and others. The mathematical acquirements of its readers are to be supposed as not going beyond a knowledge of the first four rules of arithmetic. Manuscript and printed treatises are equally admissible. The prize will consist of a medal and a sum of a thousand roubles (£154). Essays are to be sent in to the Society by September 1, 1878, at the latest. [*E. & M. Jour.* xxii, 77].

The American Institute of New York will open its 45th exhibition of arts and manufactures on the 6th of September next.

Vibration as an Anæsthetic.—Livingston mentions entire nervous insensibility caused by a lion shaking him, while terribly wounding him.

Oestberg's Fireproof Dress.—Mr. Oestberg, a Swede, has been conducting some sensational experiments in various parts of the Continent with his fireproof suit. This is made in two layers, the inner one of india-rubber, the outer one of English leather; the head being protected by a helmet resembling that worn by divers. At the girdle is fixed a piece of hose, which serves both for air and water. The air-pipe, fed from two blowers, is placed inside the water-pipe, and brings the air, after being cooled by the surrounding water, into the inner part of the dress. The air inflates the costume, passing away through the two small openings made for eye pieces. The current of air not only keeps the inclosed body cool, but drives smoke and flame away from the eyes. At the back the water-pipe divides, one branch serving as an extinguisher, the other passing into the outer coating of the dress, the stream being distributed over the whole outer surface. With the apparatus on, the experimenter stood in the middle of a pile of burning shavings and logs, without taking the least harm. [*E. & M. Jour.* xxii, 77.]

Miniature Maps.—It will be remembered that during the siege of Paris a good deal was done in the sending of Photographically reduced dispatches by balloons. The inventor of the method of reduction, M. Dagron, has lately applied it to the production of maps. In this way the whole official map of France is brought into form that can be easily carried in a pocket-book; and maps of all countries of Europe are arranged to be carried on a cartridge-belt along with the magnifying apparatus (*telémetre micrographique*), a joint invention of Dagron, Dallemagne, and Riboulet. The reduction of the maps can be on any required scale. The smaller this is the more convenient the magnification. The telemeter has the size and form of a stereoscopic apparatus. By means of it all the details of the original map are greatly enlarged, and can be easily studied. In the darkness the light of a match or even the glowing of a cigar suffices to enable one to read off the map at once. The French anticipate these maps will prove very serviceable in case of war and also for educational purposes. [*Sci. Am.* xxxii, 501.]

Name Boards of Stations.—The following suggestion of a correspondent of the *English Mechanic* is recommended to the attention of railroad men in this country:

"Much trouble would be saved if authorities in England would do as in Belgium—post up the name of the station in a conspicuous place at each end of the premises, on some blank wall at right angles to the line of rail. Abroad I used often to put out my head and read the name, at the distance of a quarter of a mile or more, on the gable perhaps of a railway shed or platelayer's cottage, whereas here on some lines you must carefully watch your opportunity (perhaps incommoding passengers next the windows) to catch a hasty sight of a name-board fixed up parallel to the rails. If the train be long or line curved, one may have to 'bother a porter' after all. Nothing is more common than to hear from a fellow-passenger 'Can you tell me what station this is?' More than once I have known the question asked just too late; the train was moving, and the bewildered traveler must wait at the next station for a return train. On some lines the porters either do not 'sing out,' or disguise the name by local pronounciation." [*Railroad Gazette*, viii, 329.]

The Cobble Stone Nuisance.—We learn from a Detroit paper that the Detroit Board of Public Works have been investigating the pavement question, and as the result of numerous experiments, they are free to state that they look upon the cedar blocks as the most economical pavement that can be laid. The stone gutters are laid because the city has the material, and the roughness on that part of the street does not affect the general traffic. Every street that is newly paved is laid either with all cedar or else with stone gutters and cedar blocks. Of all the prominent avenues leading into the Campus Martius, at Detroit, only one is paved with stone. That one is Michigan avenue, the worst business thoroughfare in the city, and it is simply the worst because of the pavement that is on it. Teams coming to the city will not travel it; the citizens will not drive their horses and carriages over it, and business men of any means will not locate upon it, because but little trade is done there. Even pedestrians avoid it as the dirtiest street in the city, the cobble stones being of such a nature that it is impossible to clean it, and a petition signed by nearly every property holder on the avenue has recently gone in to the Council asking for its re paving with wood. Real estate on adjoining streets in Detroit, where one is paved with cedar blocks and the other with stone, shows a difference of 33⅓ per cent. in its saleable value in favor of the cedar blocks. [*Engineering News*, iii, 243.]

Rheumatism.—The *Journal des Connaissances Médicales* contains a review of certain curious observations made by Dr. G. Esbach on the conformation of the fingers in various diseases. In persons that perspire easily, or in the case of disorders that induce profuse perspiration, such as rheumatism, typhus fever, etc., the transversal curvature of the nail is increased to exaggeration. This symptom, which scarcely ever fails to present itself in rheumatic subjects, has led Dr. Esbach to establish, by a statistical method, the sudoral etiology of that affection, and in the immense majority of cases he has found the following result: A man who perspires easily, and who inhabits a ground floor, becomes, sooner or later, rheumatic; if, on the contrary, he lives in a dry apartment, he is never troubled with that malady. On the other hand, a man who is not subject to perspiration may live in a damp room with impunity. Rheumatism appears thus to be placed on its real ground; dampness may be the cause of it, but only in such habits as perspire freely.

A College of Cookery.—At last a practical step has been taken towards emancipating the people from the evils of bad cookery. We know of no department in domestic economy which is so sadly in need of reform, especially in the United States. Mr. William Emerson Baker, of the sewing machine firm of Grover & Baker, has given to the Governor of Massachusetts, and to four other trustees, a farm of 50 acres and $50,000 to form a college of cookery. Cookery is to be taught as an art—which it certainly is—and the pupils are to be instructed in the scientific principles which underlie wholesome cookery. The horrible pies, fried meats, hot bread, and other dyspepsia-generating compounds, together with the inexplicable concoctions produced by the verdant Milesian handmaid, let us hope, are doomed to disappear; and instead, our kitchens are to be tenanted in future by culinary artists able to prepare, palatably and healthfully, the vast variety of food this country affords. [*Sci. Am.*, xxxv, 85-]

Progress of the French Exposition of 1878.—Ninety-four Parisian architects have recently submitted plans for the buildings in which the great French World's Fair of 1878 will be held. For six of these, a prize of $600 each has been awarded, and for an additional six, next in order of merit, the designers have received premiums of $200 each. The project definitely adopted includes a principal palace which will be built on the Champs de Mars, and in the centre of which will be the fine art gallery. The latter will be surrounded by the industrial department. France reserves to herself half the space; the remainder will be distributed among foreign nations. The buildings will cover an aggregate of sixty-eight acres, and the total expense of construction is estimated at $7,000,000.

The Spirophorus.—The above is the name of a new device proposed by Mr. Woillez for restoring partially suffocated people. The patient is enclosed in a metal cylinder, so that only his head protrudes; connected with the cylinder is a large bellows holding five or six gallons of air. When this is operated, the air is alternately drawn out and forced into the cylinder, thus causing artificial respiration in the patient. The movements of the chest of the latter can be seen through a pane of glass in the cylinder.

The Great Suspension Bridge over the East River between New York and Brooklyn.—The towers and anchorages of the East River bridge are now about completed, and the work of constructing the bridge proper will shortly begin.

The plan of operations, as given by the engineer, is as follows: A steel rope, three fourths of an inch in diameter, will be temporarily fastened to the New York anchorage, thence conveyed over the top of the tower and the coil conveyed to Brooklyn by means of a scow. The rope will then be passed over the Brooklyn tower and to the anchorage, but will be left slack and under water until late at night or early in the morning, when few vessels are passing, when it will be pulled taut. This steel rope will be also temporarily secured to the Brooklyn anchorage and the coil borne back to New York by the scow, and the ends connected, thus forming an endless rope, working on pulleys at each anchorage and on each tower, and worked by machinery on the Brooklyn side. By means of this endless rope other similar ones will be put up as required for the further construction of the bridge. First, two steel wire ropes, 2⅝ inches in diameter, will be carried across and made secure to temporary fastenings at each anchorage. These will be 3½ feet apart, and placed a little to the south of the middle of the tower, running over the top. They will be used for the construction of a temporary bridge for the use of the workmen. Oak planks, 1½ inches in thickness, will be laid upon the ropes, with spaces of about half an inch, both for the purpose of economizing material and to lessen the effect of the wind upon it. They will be fastened by strips running lengthwise across the ends, which will be bolted to the ropes by U-shaped clamps.

The bridge will be completed by stretching small ropes on

each side about 3 feet above flooring and secured to every ten feet. It will be rendered firm by guys.

Three other steel ropes, of the same magnitude as those used in the construction of the foot bridge, will be stretched across the river over the tops of the towers—one 27 feet south of the foot bridge at the edges of piers, one over the north edges, and one midway between the north and the foot bridge, with a space between the north and south ropes of 81 feet. The object of these last-mentioned ropes is to support small cross bridges, technically called cradles, and necessary for the construction of the other portions of the bridge.

There will be five of these cradles, one in each land span between each tower and its anchorage, and three at equal distances in the river span. They will project ten feet beyond the outside cable, and will support pulleys for the endless ropes. The whole temporary structure will be 200 feet above high water at its center and lowest point, so that no water craft will be interrupted by it. After this work is completed, the construction of the bridge proper will be proceeded with, and the first step will be the stretching of the main cables, which will be put up at the same elevation as temporary bridge and lowered. These cables will be composed of ninteen strands, each strand being made up of 330 wires, No. 7 gage—that is a little more than $\frac{1}{8}$ of an inch in diameter. The material used will be the best quality of steel wire. The ropes of the temporary bridge will not be taken down, but finally incorporated into the superstructure of the bridge.—[*Sci. Am.* xxxv, 99.]

CENTENNIAL NOTES.

The "Single Rail" Road.—This is a safety railway, crossing the Belmont ravine at a height of about 35 feet, and possessing several good features, especially adapted for uneven districts. The road is known as plan of Gen. Le Roy Stone. There is a T bearing-rail laid on a wooden stringer 4″ x 8″, resting on the top of a row of posts, and flanked by a pair of side-rails, 4 feet 5 inches below the bearing rail, and 3 feet 4 inches apart; the system being well cross-braced, and making a triangular truss. The car runs on bearing wheels on the centre or top rail, and is saddled over the truss; horizontal guide wheels at its bottom, steadying it against the side-rails. The car framing is largely of iron, and is well braced; its weight being but 9,000 lbs. for a carrying capacity of 60 passengers. The seats are in two tiers on each side; the upper seats facing each other as in a horse car, the lower ones back to back, "jaunting-car style.

The locomotive is saddled on the rail in the same way as the car; the boiler and engine occupying the upper tier. The engine is a rotary (La Francés modification of the Holly) and *works directly on the driving axle*, and is reversible; an excellent feature, claimed here as novel, but which was suggested to the West End P. R. W. Co. of this city by the writer, some year or two ago, in response to the demand of that Company for a street-car motor. The motion is smooth, and the steadiness increases with the speed.

The cost of the road is given as $4,500 per mile; bridging no extra cost.

The Yale Time Locks.—The protection of valuable property from burglars has led to a great deal of thought and ingenuity in the manufacture of locks that would thwart the skill of the shrewd robber, and the many instances where banks have been relieved of large amounts of cash by one of the prominent officials being forced to reveal the combination with which the safe is locked, or to accompany the daring robbers to the bank and open the safe for them has caused the lock manufacturers to strive to produce a lock that would be proof against even the bank officials themselves, except during regular bank hours. To this end the combination of clock-work with locks has been brought about, and the Yale Lock Manufacturing Co. is manufacturing a lock which is placed inside on the door of the safe, so that when closed it cannot be reached by any one. These locks can be so set that they will open at any hour desired, but so that no one can open them previous to that hour. The clock-work is enclosed in a glass case which is locked and need never be opened except to set the hour at which the lock is desired to be opened, which if a uniform hour requires to be set but once, and afterwards requires no attention except winding, which can be done through an eyelet pierced through the glass case—thus preventing unauthorized persons from tampering with it. The clock mechanism is cushioned between springs so that no jarring or sledging of the door can effect it. It can be set so as to remain locked from Saturday night to Monday morning; or to open during the day-time of Sunday, as may be desired. This lock will receive a more detailed description in a future number of the REVIEW. There are over three hundred banks now using these locks; and the Company has received a number testimonials from those using them, stating that they are very much pleased with them. The locks can be seen and examined at the Company's exhibit, P. 72, Main Building. C. K. H.

Tobacco Manufacture.—Above the noise made by the working of the machinery, the visitor to Machinery Hall hears at intervals coming from the direction of the upper end of the Hall, a sound decidedly musical, which is at once recognized by the Southerner as the singing of negroes at their work; following the sound to its source it is found to emanate from the exhibit of Archer & Brownell, tobacco manufacturers, from Richmond, Va., located at Section F, Column 58. Here, at all hours of the day, the negroes may be seen at work making either chewing or smoking tobacco, and ever and anon they burst forth in song to help relieve the tedium of their labor and interest the visitors. The tobacco used by this firm on the grounds is of the best used in their manufactory, and quite a business is done by them in selling tobacco in every shape to those visiting the Centennial C. K. H.

—E. S. Johnston exhibits at Section T. 53, Main Building, his patent Shade Roller. In connection with this exhibit, he has the figure of a lady standing as if in front of a window; this figure has a concealed clock-work apparatus, which is moving, her hand up and down; she has hold of the shade with this hand, and with its downward and upward motion raises and lowers the shade, thus showing the ease with which the shades may be used. The exhibit is well worthy examination by those who desire convenience in shade rollers.

C. K. H.

—One of the chief attractions in the Pump Annex, Machinery Hall, is the exhibit of the Champion Ventilator, by Mr. Francis Murphy of Chicago. This ventilator is capable of carrying a large volume of air, and will blow either in or out. It will be found of great service in the ventilation of mines, tunnels, large buildings, etc. There are some of these ventilators very satisfactorily in operation in the West, and others are being built for the Anthracite region. A full description will be given in a future issue of the REVIEW.

C. K. H.

RAILWAYS AT THE CENTENNIAL.—Messrs. Hussey, Wells & Co., of Pittsburgh, have filled a space of 14x17 feet with specimens of the goods which they are making and selling daily. The most noticeable are the boiler plates of homogeneous crucible steel, for which this concern has become noted, and of which it was among the first manufacturers in this country. The largest is 84 inches in diameter, $\frac{1}{2}$-inch thick, with 7-inch flanges, two flue holes of 18 inches diameter each and one of 26 inches. The tensile strength of this plate is 76,000 lbs. to the square inch. It is the largest crucible steel plate in the American exhibit. Since 1865, the firm has furnished about 10,000 tons of this plate to railway companies and locomotive builders for boilers and fire boxes.

They also show a steel axle of the Pennsylvania Railroad pattern which has been struck five blows, reversed each time, by a 1,600 lb. drop falling 25 feet. It is bent without fracture. There is also a number of railway forgings, crank pins, frog points, specimens of refined steel for edged tools, car and locomotive spring steel, sheet steel, etc. For the production of the last, this firm has the largest plant in the United States, consisting of one 20-inch, one 18-inch, and two 16-inch trains.

The Cleveland Rolling Mill Company fills a good sized space with its various manufactures. One case—there are fifteen in all—contains 60 different kinds of wire. There are three pieces of steel rail, each 7 feet long, which have been twisted cold, four turns, without discovering any flaw. A remarkable record is that of a rail made in 1868, which has *outworn thirty-four good iron rails*, has been traversed by locomotives 766,500 times, by 6,387,500 cars and 143,080,000 tons weight. It would be hard to find a better illustration of the economy of Bessemer steel, or the vast results it will accomplish in cheapening transportation. The remainder of this exhibit consists of steel rail ingots, axles, forgings, horse-shoe steel and Lake Superior ores from the company's mines.

The Cambria Iron Company has skillfully arranged its specimens in a sort of triumphal arch. Its exhibit is probably the largest of any in this line. It consists of 1876 pieces weighing altogether thirty tons—three car loads. There are between 50 and 60 patterns of rails, of all weights from 16 to 83 lbs. to the yard. Some are new, just from the mill and ready for use. Others are twisted, cold, without flaw or blemish. Many are old rails which have done long and honorable service and have won the right to retire "on their record." Most of these records are indeed remarkable for the long term of the service in trying positions and the present good condition of the veterans.

The Lackawanna Iron and Coal Company shows samples of ores from its mines in Morris and Sussex counties, New Jersey, and Crown Point, New York; and manufactured iron and steel from its works at Scranton, Pa. The different ores used for making bar and railway iron and Bessemer steel are each accompanied by an analysis. There are pig irons of the various grades; puddled bars dry and boiled, for making rail heads, flanges of rails and merchant iron; samples of double-refined merchant iron, bent cold under the severest tests, and samples of the same under the severest hot tests; merchant iron which has been subjected to great tensile strain; iron and Bessemer steel rails 60 feet long; and of merchant and axle iron twisted into cables.

The Albany and Rensselaer Iron and Steel Company has a display in the same line as the preceding. It manufactures all kinds of iron and steel for railway purposes, and the well-arranged exhibit includes Bessemer steel and iron rails, merchant and angle iron of all sizes, merchant bar and spring steel, Bessemer steel shafting and crowbars, iron and steel cut nails, railroad axles and fish plates, bolts, and nuts, and fish joints, boiler rivets, finger bars and shapes, railroad frogs; railroad, boat and ship spikes, patent horse-shoes, pig iron and iron ores.

Messrs. W. D. Wood & Company, of Pittsburgh, exhibit their planished iron which is used largely for locomotive jackets. It has an excellent polish and need not fear comparison with the genuine Russia. All the locomotives at the Exhibition, but two, have their boilers jacketed with this iron. It can be compared by examining the Rogers locomotive in Machinery Hall, on which the Russia is used, with the Baldwin standing opposite. The American planished iron is now, we are informed, used on nearly all the railways of the country, and gives greater satisfaction for jackets than the imported article.

The Adirondac Steel Works, (Gregory & Co., Jersey City), shows tool steel, frogs, crank pins, slide bars, railway springs, etc.

The Chrome Steel Company's exhibit consists of samples of the ores which they use, and bars and rods of chrome steel which has attained considerable celebrity through its use on the St. Louis and Brooklyn bridges.

The Bay State Iron Company, of Boston, has sent here some huge homogeneous metal plates.

The Co-operative Steel and Iron Company, of Danville, Pa., shows some light street and mine rails.

Cooper, Hewitt & Co., of New York, have a large display, consisting of rolled iron beams, channels and angles, merchant iron, brazier and wire rods, iron and steel headed rails, chains, Martin steel, Goodenough horse shoes, etc.

The Otis Iron and Steel Company, of Cleveland, shows crank pins and forgings, and open hearth steel.

Messrs. Traber & Aubery, of Cincinnati, have a fine show of car wheel irons, consisting of pig, broken car wheels showing the quality, and chill tests, from Hanging Rock ores. [*Railway Review*, xiii, 35.]

Exhibit of Railway Car Springs.—Among the exhibitors of railway car springs at the Centennial, the National Car Spring Company, of New York, displays at D–65, Machinery Hall, a great variety. The materials used in their manufacture are steel and india-rubber. These are employed either separately or in combination, the rubber being combined with steel in various kinds of coiled spirals, claimed to produce a modified action better suited to sustain a continuous heavy pressure, than the action of the steel alone. The well-known volute springs are conspicuously shown, and are merely a flat slab or plate of steel rolled up like a shaving. When made of a good quality of steel, and properly tempered, they have a rigidity and power indispensable for buffers. Dinsmore nest-spirals of various sizes are also exhibited. They are composed of several coils made of fluted steel bars placed one within another and forming a nest. They are used both for buffer and bearing purposes, and as respects elasticity, power, absence of friction, and a soft, easy action, are not surpassed by any car spring made exclusively of steel. The Hebbard spring is similar in construction, the bars of steel being square, with rounded edges, instead of fluted. The well-known small rubber-center spiral freight springs, grouped in cast-iron cases, are also exhibited; also the "Drip" or spiral-cluster spring, consisting of larger coils of round steel bars, without rubber, arranged six in a group, and held in place by top and bottom seat-castings; also a large spiral coil spring for equalizing bars, two coils in a nest, the outside one of 1-inch round steel and the inside one $\frac{3}{4}$-inch; also round-bar nest springs; large rubber center and compound spirals for heavy freight work; a large rubber center and steel coil spring for passenger car trucks; rubber cylinders with a single coil of steel inside and outside, etc. The exhibit includes solid rubber springs of various sizes and forms, designed for passenger freight and horse cars. There are a number of specimens of the Cliff elliptic spring, which is an improved modification of the ordinary elliptic. Indeed, there is scarcely any form or combination into which steel or rubber can be wrought for sustaining heavy pressures and resisting concussion, that is not shown in this exhibit, all of which are the product of inventions to meet the the requirements of railways, and which were quite unknown fifty years ago.

The National Car Spring Company is a new organization, to which has recently been transferred the extensive car-spring business of the well-known firm of Vose, Dinsmore & Co. The manufactory is located in Newark, N. J. [*Nat. Car Builder*, vii, 118.]

BIBLIOGRAPHICAL NOTICES.

ANATOMY OF THE INVERTEBRATA, by C. Th. v. Siebold; Translated from the German, with additions and Notes, by Waldo I. Burnett, M. D. Boston: James Campbell, 18 Tremont St.

To the student of natural history who seeks a handbook wonderfully simple in its arrangement, and exhaustive in its treatment of the various branches of invertebratic anatomy, this excellent translation offers everything that one could need—save the very important feature of illustrations. Dr. Siebold's detailed references to author, volume, page, and plate or paragraph atones in part for this lack, where one has the originals to refer to; but the objections advanced in 1848 as to the transfer of illustrations being attended with change and error, no longer holds good in these days of cheap and accurate photo-engraving. The wonderful care and accuracy of the original work, in which the details are elaborated and arranged with a patience and fidelity peculiarly German, lose nothing at the hands of Dr. Burnett, and we hope that there will be due to the American publisher the honor of reproducing the illustrations so liberally referred to throughout the work.

The "AURORA BRAZILEIRA," published in the Portuguese language at Syracuse, N. Y., is a handsomely printed and illustrated technical monthly, designed for Brazilian circulation. It is conducted by Mr. J. C. Alves Lima, an alumnus of Cornell University; and we give it this second notice in our columns because it seems likely to prove of great value in promoting close and profitable relations between this country and the empire of Santa Cruz.

THE AMERICAN IRON TRADE IN 1876, Politically, Historically and Statistically considered. By James M. Swank, Secretary of the American Iron and Steel Association. Annual Report to January 1st, 1876. Phila.: the Am. Iron and Steel Assoc., 1876. (198 pp. 8mo, with chart.)

The main portion of this very useful publication is devoted to a comparative statement of the Industrial Policy of Great Britain and of the United States; in which the benefits of the protective policy are set forth and substantiated by the logic of facts and figures, in the masterly fashion with which Mr. Swank can handle this subject.

The historical sketch of the American iron trade which follows, contains much information of interest regarding the establishment and growth of the iron Industries in the American colonies and States. Some 40 pages of statistical information follows the above, which includes a series of tables, showing the production in the United States of all forms of raw and manufactured iron and steel for a series of years up to January 1st, 1876. Besides the above the Secretary has compiled a valuable chapter of miscellaneous statistics, including railroad immigration, and coal statistics of this country for 1875, iron and coal production of the world, and the same of Great Britain and Germany, etc. The work is accompanied by a chart, showing graphically the prices of American No. 1 anthracite pig iron and iron rails from the date of first quotation in prices current; and of Bessemer steel rails from the date of their first manufacture on order in the United States.

A BRIEF TREATISE ON U. S. PATENTS, FOR INVENTORS AND PATENTEES. By Henry Howson and Chas. Howson, authors of "The American Patent System," etc. Philad'a.: Porter & Coates, 1876. 164 pp. 12 mo.

This is such a handbook as we should expect from patent lawyers of the ability and experience of the Messrs. Howson. It gives much valuable information to would-be patentees; and the citation of authorities in defining the nature and scope of patents, renders it valuable to lawyer and layman alike. The index is especially full and complete. Apparently (at first sight) the authors are putting it in the way of the multitude to become "every man his own patent-lawyer;" but when we consider their large practice, and the peculiar nature of a large part of it—the *re*-taking out of imperfectly issued patents obtained by amateurs or by second-rate attorneys—we see that they are protecting themselves and their clients from a great waste of time; and at the same time are educating the inventive class to a proper appreciation of what a patent should be. The Messrs. Howson appreciate the fact that a *well-informed* man makes the best client; and their book is one *very* well worth having. G.

IMPORTANT PAPERS, too long to reproduce in our columns.

ON THE NEW SCIENCE OF GRAPHICAL STATICS. Prof. Mansfield Merriman, in *Eng. News*, iii, 236.

SHOPS AND SHOP BUILDING. J. W. Carpenter, in *Eng. News*, iii, 240.

THE SOUTH MISSOURI LEAD DISTRICT. G. B. Brodhead, Pleasant Hill, Mo., in *E. & M. Jour.* xxii, 59. Read before the Am. Inst. M. E.

WASHERS OR SCRUBBERS. Read by Mr. C. Hunt before the British Assoc'n of Gas Managers. *Engineering*, xxii, 43.

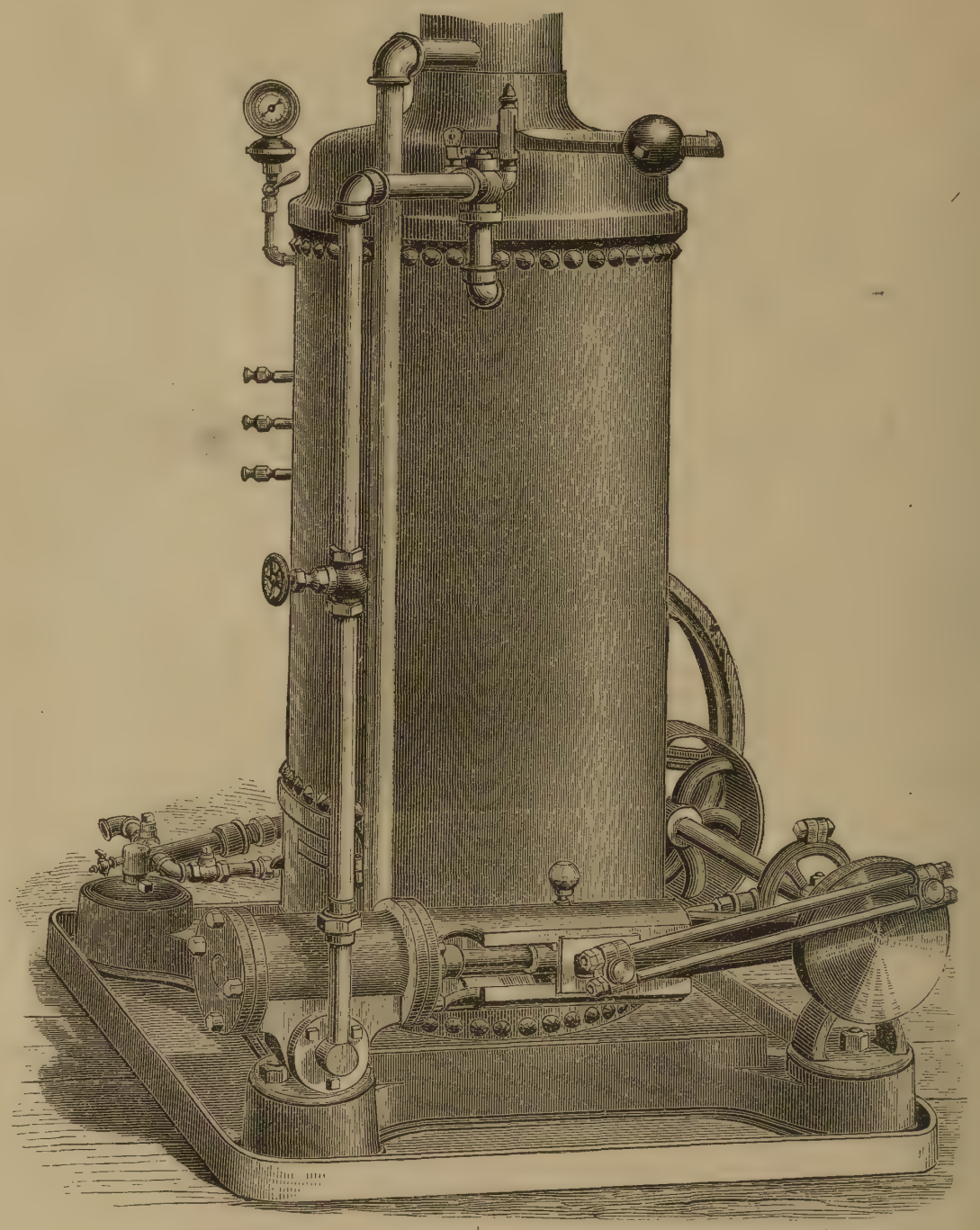
ON MECHANICAL PUDDLING. Read before the Inst. Mech. Eng. In *Engineering*, xxii, 61.

DYNAMOMETERS AND BRAKES. Wm. E. Rich. Read before the Inst. Mech. Eng. In *Engineering*, xxii, 62.

OBITUARY.

CHRISTIAN GOTTFRIED EHRENBERG, the famous naturalist, died in Berlin, on the 28th of June, in his 82d year. His microscopic studies of the *infusoria* entitle him to lasting remembrance.

INDUSTRIAL DEPARTMENT.



THE WHITMORE ENGINE.

The advent of the steam engine marked a new and wonderful era in the progress of all departments of manufacture, and upon every occasion where the use of motive power is requisite. It is unnecessary to enter into details or elaborate upon the many uses to which this great agent of modern enterprise has been applied, as its history is familiar to most of our readers, and we have not the space to enter into lengthened details. Suffice it to say that its invention was hailed with surprise and delight by all scholars of science and mechanical industry, and that it has worked a great revolution in the marvelous advancement made in enlightened countries during the nineteenth century. Since the introduction of the first steam engine many valuable improvements have been made in their construction, and the styles now in the market are varied and embrace a wide field of invention.

Simplicity of construction is one of the most important features of merit in any article of machinery. In this essential it is conceded that the Whitmore patent steam engine, illustrated on this page, takes a prominent place in the market among the multitude of engines of small power. The arrangement of this motor is novel, being an ordinary tubular boiler with a horizontal engine, the whole being mounted on a cast iron base of improved design. The claims advanced for the Whitmore engine are: First. Its extreme simplicity. Consisting of fewer parts than an ordinary engine, with nothing more or less than is actually necessary, its action is readily understood by the inexperienced, and at a glance they are equal to the task of running it. Second. Economy in fuel. This is accomplished by a peculiar valve hung on a rock shaft to reduce friction, and set in such a manner that the steam is used expansively. Third. Economy in space; the four horse power requiring a space of but 41 inches square, the five horse power but 43 inches, and the ten horse power 63 inches. In height the largest size requires but 90 inches. Fourth. Accessibility of parts. Any portion of the engine and boiler can be reached very readily for repairs or cleaning without having to disconnect or removing any other part. The pump, the most important of all accessaries, is immediately in front and easy of access at once should it fail to perform its duty. Fifth. Perfect safety from fire. This is accomplished by the improved design of the base, by which the drip from the exhaust pipe keeps a continual supply of water on hand in the water bottom, into which all ignited coals or ashes must drop.

These engines are furnished complete with all the necessary fittings, ready for steam, at prices to suit the times; the particular points in their manufacture being simplicity with cheapness and durability. In the west they stood the crucial test by the committee on motive power, and received silver medals at both of the Cincinnati Industrial Expositions of 1873 and 1874; and, although but lately introduced in this section of the country, are fast becoming popular among steam users where light power combined with compactness is required.

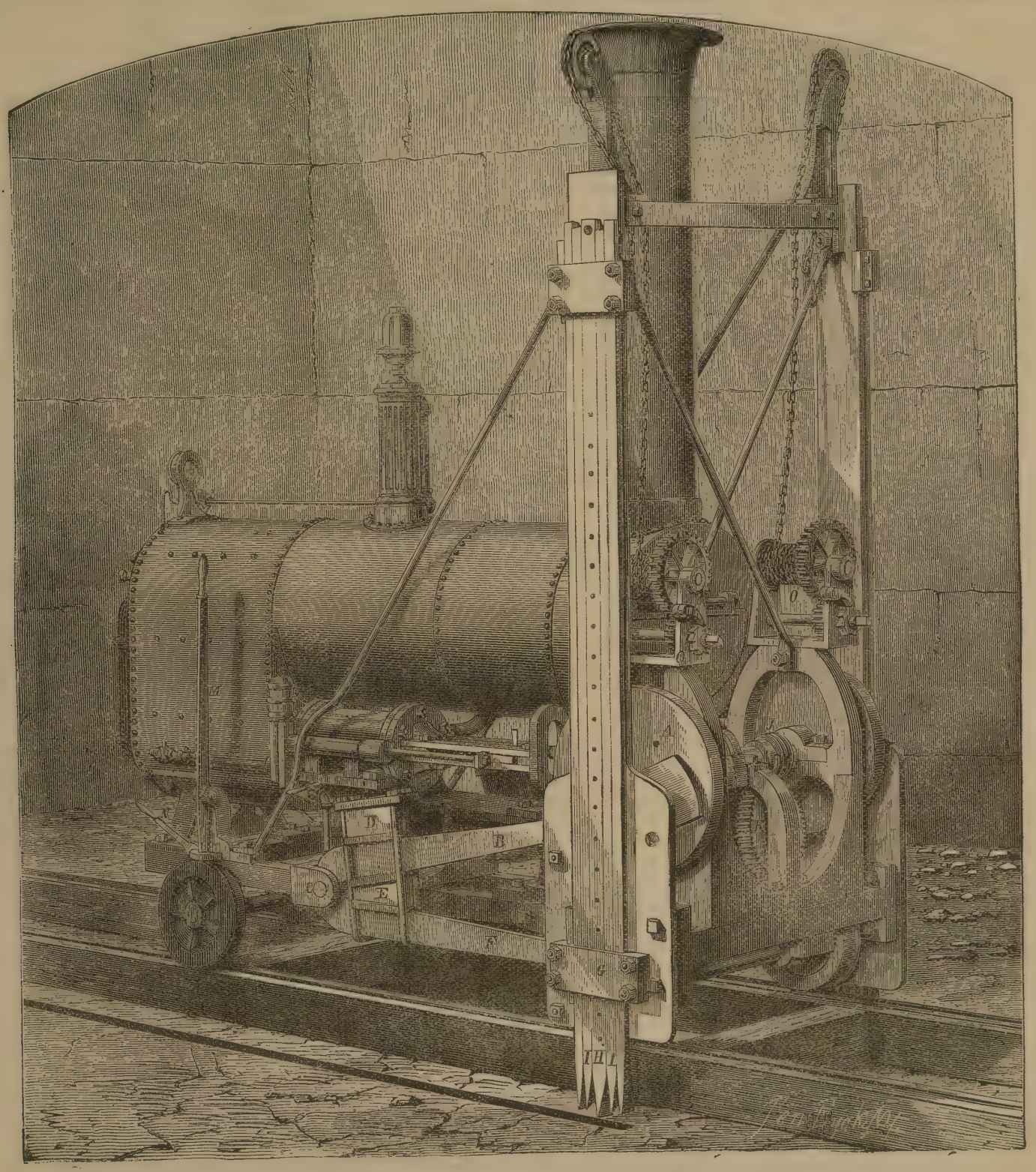
They are exhibited in Machinery Hall, column B—75. For further particulars address Lovegrove & Co., 121 South Fourth street, Philadelphia, sole manufacturers, who will answer all inquiries pertaining to same, or to any other styles or sizes of engines and boilers they manufacture.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, AUGUST 19, 1876 NO. 7.



THE WARDWELL STONE CHANNELING AND QUARRYING MACHINES.

(ANNEX No. 2, MACHINERY HALL, CENTENNIAL EXHIBITION.)

The largely increasing demand for stone for building and other purposes, calls for the introduction of labor-saving devices, which, while increasing the supply, lower the cost of production. To this class belong the machines herewith illustrated and which are extensively used for quarrying throughout the country.

The Steam Stone Cutter Company, of Rutland, Vermont, shows two machines for stone channeling; one single, and one double; the latter of which we illustrate herewith.

The following is a description of the double gang machine as represented mounted on its track on the bed of the quarry. The frame which supports the boiler, engine and other machinery, consists of one piece of forged iron, weighing nearly a ton, thus furnishing great strength and durability. The engine is of six horse power; its shaft carrying a balance wheel A on each end, to which is attached an adjustable wrist pin plate. B and F are levers pivoted at their rear ends to the frame at C. The free end of the lever B passes through a sliding stirrup or swivel attached to the wrist pin, (not shown) giving an up and down motion to that end of the lever, as the balance wheel A revolves. The free end of the lower lever, F, passes through a mortice in back side of lower clamp G. Motion is communicated from the upper to the lower lever, by means of clasps, between which the rubber springs, D and E, are placed as shown in the engraving. The free end of the lever F actuates the gang of chisels, which consists of five bars of the best cast steel, sharpened at their lower ends, and clamped together by head and foot clamps; the whole sliding freely on the standard. Of the five chisels, two I I have diagonal cutting edges, and three have their edges transverse. The middle chisel H extends the lowest and altogether form a stepped arrangement each way from the center; thus it will be seen when the machine is moving forward the front three cutters, which includes the middle one H, operate; while moving in the opposite direction, the other two, with the middle one, H, perform the work. The object of the diagonal cutting edges is to insure an even bottom to the channel. These bars of steel are from seven to fourteen feet in length, according to the depth of the channel to be cut. The upper ends of these bars are serrated to match corresponding serrations in the head clamp, for the purpose of preventing any displacement of the cutters while in use. J is a worm on the main shaft and actuates the toothed wheel K. The shaft of the latter extends diagonally downwards to the rear of the machine, where it terminates in a bevel pinion; upon the rear axle are placed two bevel gears, one of which is shown in part at L. By means of the lever M, either of these beveled gears may be thrown into action with the pinion. It will be readily understood that the

motion thus communicated serves to turn the axle either backward or forward, acccording to with which wheel engages the pinion. When the machine is required to be stationary, these bevel gears are so placed as not to engage with the pinion. The short lever N, locks these bevelled gear in either of the desired positions. The windlasses, O O, on each side of machine, are for raising the gangs of cutters out of the channels. The opposite side of the machine is, of course. the same as that already described.

The length of the double gang machines is 10 feet, and they are made of three different widths, respectively, to cut channels 4 feet 1 inch, 6 feet 3 and 6 feet 7 inches apart, and cut two channels at once.

The length of the single gang machine is 7 feet, width 6 feet, and it cuts either vertical or inclined channels down to 45 degrees; the cutting apparatus with its operating machinery is made adjustable for operating upon either end of the machine, thereby making it a right or left handed machine, adapted to cut in all corners.

Weight of double machine, 4½ tons; shipping weight, with all the fixture, 6½ tons.

Weight of single machine, 2½ tons; shipping weight, with the fixtures, 5 tons.

The double machine has a 6-horse horizontal boiler and engine and the single machine, a 5-horse vertical boiler and engine; they are supplied with lock-up safety valve set to carry 80 lbs. steam.

The machines are supplied with 100 feet of track and a full set of tools and fixtures, and the double machine with 8 gangs and single with 4 gangs of cutters.

They are locomotive and cut moving in either direction, and are reversed without stopping, and either or both sides of double machine may be operated at pleasure.

It requires two men to operate single and three to operate double machines, using from 300 to 400 pounds of coal per day; the cost of operating is stated as from $7 to $10 per day.

The single machine strikes 150 and the double 300 blows (150 on each side) per minute; feeding forward on the track ½ inch at each stroke, or 6 feet per minute, and cutting from ½ to 1 inch in depth, (according to the stone) each time of passing over.

The single machine cuts from 40 to 80 square feet of channel in marble and limestone and 80 to 100 in sandstone per day, and will do the work of 25 men.

The double machine cuts from 75 to 150 square feet of channel in marble and limestone and 150 to 200 in sandstone per day, and will do the work of 50 men.

The makers claim that channels 4 feet in depth can be cut for ¼ and 6 feet deep for ⅕ the cost of cutting the same by hand labor.

Channels are usually cut from 4 to 6 feet deep and 1⅓ inches in width, except in sandstone, in which they are cut 2 inches wide, and they can be cut within 3 inches of the parallel wall of a quarry, and have been cut 13 feet deep.

Machines for sharp grit sandstone are fitted expressly for that purpose with short guides and cutters specially adapted for that stone, one of which is also on exhibition. In these the standards and chisels are shorter than in the marble machines.

Each alternate tier of blocks can be cut of any desired width by placing the machine a greater or lesser distance from the channels previously cut, or channels can be cut between, thus giving a great variety of sizes, even with double machine.

The channels cut are straight and true like a tooled face, and every foot of channel cut makes two feet of cut surface on the blocks, which should be worth all its cost in cutting (incidental to quarrying) in the enhanced value of the stone alone, over the old process.

The stone is all saved in quarrying with these machines, and the saving of stone, over the old process, is said to be sufficient in many quarries to cover the cost of a machine in one season.

Clean, open channels can be cut with these machines for less than half the net cost of any ordinary process.

Parties using such machines can increase their production so as to practically meet any demand or take any contract offered and fill it promptly and avoid all strikes.

The makers state that the double machine has cut in West Rutland marble 173 feet in one day of 11 hours; 859 feet in 5 days of 11 hours each, and has averaged over 100 feet per day by the month.

The machines are mostly wrought iron and made in the most substantial manner, and in the hands of skilful operators should need few repairs, as the concussion from the blow is confined to the gang of cutters and completely cut off from the machine by the intervention of the compound yielding levers with rubber springs, which are connected to and operate them.

MACHINERY FOR WOOD BENDING.

The utility of bending wood to the multiplicity of forms required for heavy as well as for light structures, is having a growing appreciation.

It is no longer an experiment, that ships of the most profitable tonnage may be built with long timbers, bent to the required forms, being sawed to taper and beveled before being bent.

Every improving change affecting nautical commerce must, of necessity, be of slow growth; changes, however improving, must be well digested by ship-owners, underwriters, and ship-masters before they are adopted. Ship-builders themselves hesitate to employ machinery which requires an outlay of thousands of dollars; they must know that their financial success depends upon their being supplied with this adjunct of the saw-mill before they are ready to provide their ship yards with such machinery. Hence we find that while the less important departments of wood bending have been utilized to meet the wants of husbandry in the field, and furniture in the house, wood bending for flotative utility upon the ocean has been of slow progress. It could hardly be otherwise, when it is considered that the durability of bent wood ships had to be settled in the minds of ship owners—a difficult problem, and one which time alone could determine. The ledgers of Insurance, too, had a story to tell in regard to vessels for ocean service, both wood and iron. The history of bent timbers for ships, therefore, had to be written under the strong light of old theories and departed prejudices.

The sequence has been that this manufacture, within the last quarter of a century, has not improved, while ships have been built very much larger and proportionately weaker than formerly; the result has been that shipwrecks have been more frequent, and the loss of property and life more appalling.

The question of relative weakness growing steadily with the increasing bulk of vessels, seems never to have been seriously considered in the light of a principle in mechanical philosophy by the ship-owning and navigating fraternity.

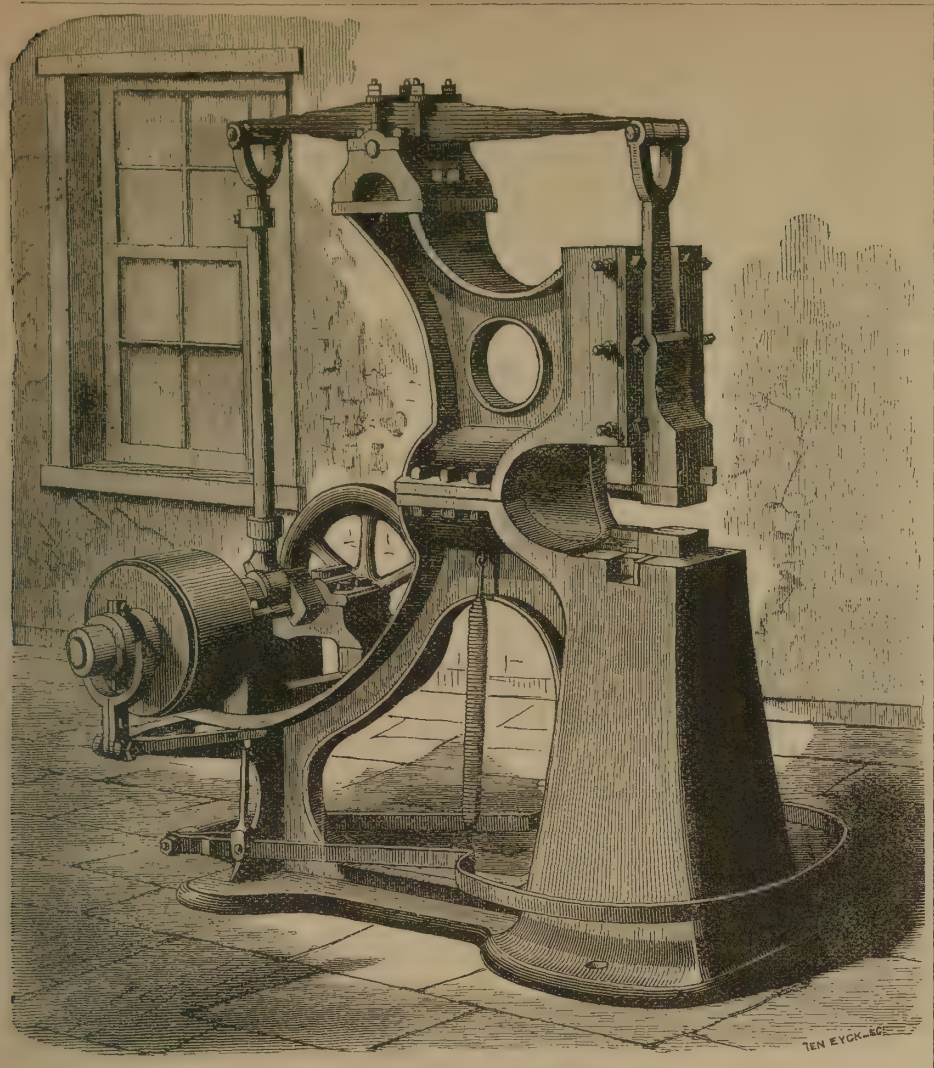
The nautical and ship-owning world, having been educated in the school of experience, have learned that the number of lengths, both in the timbers of the frame and in the state of a vessel's planking, have a relative bearing on the strength of the fabric; hence the desire to obtain long timbers for the frames of vessels. Another fact has been recognized by experience—that the bottom is required to be as strong as the sides of vessels, and that where vessels are expected to be stranded without injury, the bottom must be solid; but bottoms of solid iron were out of the question, and a filling of concrete or cement has by no means proven satisfactory; and as elasticity has been shown to be a necessity, experience has also shown that a filling of wood is both stronger and cheaper than other fillings for the solid floor of vessels. But if the bottom should be of wood, why not the sides and bilge? hence the pertinent inquiry, can the timbers of sides, bilge and bottom be bent in single length from keel to rail?

It has at length been conceded, that in ship, as in other departments of industrial development, *confidence* is the great want of the present time. And where a more fitting place for its introduction than in the world's flotative transports?

All business transactions of importance hinge upon permanence and durability. The durability of bent timbers for the frames of vessels, was settled in the case of the U. S. S. "Pawnee," which after some seventeen years of service in that vessel, were found to be sound; the strength of timbers has been demonstrated by a test under the direction of the Government, some twenty years since; while the construction of the sailing ship "New Era" has set at rest the strength of ships built of bent timbers in single length from keel to rail. The record of the vessel, up to the present time, has shown that, unlike other vessels of equal tonnage, she is competent to carry dead weight cargoes on long voyages; and when driven in a heavy head sea, shows no signs of weakness, and makes no water. It is a knowledge of this fact which has brought a new and improved set of rules for the construction and characterization of vessels, for both Lake and Ocean service, and has elicited a deep interest in the wood-bending machinery now on exhibition in Machinery Hall.

This machine, though not of the largest size, being a number six, is competent to bend the timbers of a vessel of three to four hundred tons, in all the variety of forms required for vessels of every type of model.

We can best give our readers an idea of the Universal Wood Bending Machine by describing it. These machines are of various types, but all involving the same principle. The one in Machinery Hall has a slotted table some ten feet long, by five or six feet wide, mounted upon legs of a convenient height above the floor; at a point in the length, the sides are swelled out, opposite to which, in the centre of the table, there is a revolving disk, rising above the surface some quarter of an inch, for giving clearance to all revolving projections beyond the disk as it revolves within the table. This disk is slotted, the slots radiating from a central hole some three inches square, the diameter of this revolving disk gauged to the work to be done. This machine being a number six, has forty inches diameter, upon which is mounted a curved platform some six to eight feet long, ribbed on the lower side, so as to receive screw bolts with T heads. This platform being bolted to the disk with socket bolts, leaves it free to receive adjustable holders with hinged lids and projecting arms, upon and into which the timber finds its place at the disk and its mountings are revolved. At one end of the platform, the smaller end of the timber is held by a clamp, which has an adjustable attachment to the disk, while a steel strap covers the outside of the timber with a clamp attachment to the farther and larger end of the timber, the clamps have a screw in the part bearing against the end of the timber; these screws are adjusted to bring the strain on the steel strap, instead of the timber, while being bent. The larger end of the timber is placed within a holder against a roller—this holder is secured at the extreme end of the table. The straight timber having been steamed one hour or more, is taken out of the steam-box and placed, as before stated, with the ends between clamps and a steel strap on the outside, the form the timber is required to take being set with the holders on the platform, and the small end of timber being laid on and secured to the first holder—the disk with its attachments is revolved by means of gearing below the table—the motion is adjusted to the power, and time required to drop the lids of the holders, and fasten the timber in place, as the holders present themselves to the front and receive the timber. As the timber is wound into the form, the larger end moves along against the roller, until the bend is made, which requires some two or three minutes after the work is commenced. In the process of bending, the wood has been compressed or shortened in its length on the inside. Experience has demonstrated that the wood is improved by bending; the air and moisture from the interior of the wood being brought to the surface, the wood fibre takes its place. In a ship yard where the space and appliances are at hand, timbers for both the frame timbers are bent at the same time, are immediately taken out of the machine and laid aside to dry, while another pair is being bent; and thus the machine is set to the form of each frame, and the timbers are bent in pairs for the opposite sides of the vessel. The beams may be of the same siding size and placed against the inside of the timbers, while the knees are placed on the sides of both the timbers and beams, and bolted to both, making the frame complete. By this arrangement, not only the strength of the vessel is increased by increasing the number of hanging knees, but the vessel's capacity for freight and convenience for passengers is increased, by removing the knees from the lower sides of the beams. Thus, while the timbers and knees are being bent for one frame, other frames are being put together and raised. The knee bending attachment is also simple. A platform, from which projects two vertical rollers, against which the parts near the ends of the timbers are pressed in clamps having a connecting plate. A screw in each clamp secures the timber in place. A form, such as the throat of the knee is required to have, is then thrust forward by screw power to the middle of length of the straight timber, and thus between the rollers the form crowds the wood outward until it takes the angle for the arms of the knee, and the shape of throat furnished by the form itself, when it is clamped and taken out to dry.



PALMER'S POWER SPRING HAMMER.

The accompanying cut shows Palmer's power spring hammer, made by S. C. Forsaith & Co., Manchester, N. H., and shown in Annex No. 1, Machinery Hall.

The machine consists of a frame and anvil block, having suitable bearings thereon for shafts, pins and other moving parts. Two of the bearings are occupied by a crank shaft, a friction clutch being used to transmit motion to the shaft, and a balance wheel to give it a uniform movement. The crank is connected to one end of a flexible beam or lever formed of a series of springs and pivoted at the top of the frame. The other end of the lever is attached to the hammer head, which, together with the anvil block, is provided with dies, keyed in their respective positions. The friction clutch, which is the means of regulating the velocity and impact of the blows, is moved by the foot of the forger through the medium of a lever, which, to make it accessible from any side of the anvil, passes entirely around it. The movement at the clutch is thoroughly under the control of the operator, so that the blows struck may be regulated to the greatest nicety, giving a hammer of a given weight an extensive range, and adapting it to a great variety of work. The weight of the hammer-head is counteracted by the formation of the balance wheel, which allows the head to remain in any position without a tendency to move. There are nine sizes of these hammers, with rams varying in weight from 15 lbs. to 175 lbs. ; the complete machines weighing from 800 lbs. to 5,000 lbs. The hammers deliver from 100 to 500 blows per minute, and are suitable, according to their size, for all kinds of work, from small cutlery forging to bars six inches square used in the construction of heavy machinery.

THE WESTCOTT TYPE CASTING AND SETTING MACHINE.

As the results produced by the Westcott Type Casting and Setting Machine* are valuable only to the extent that it simplifies and economises the labor of type casting and setting, it has been necessary, in the present brief mechanical description of the machine, to institute a comparison between the present method and that adopted by it, and for this purpose it became necessary to give a general idea of what the present method is.

It is well-known to those who are acquainted with the manufacture of type that these pass through many operations before they are ready to be placed in the printer's hands. The first operation is casting, and that leaves the type with edges more or less rough and with a "jet," a piece of waste metal adhering to the foot when the metal was injected. In this state they are of course unfit for use ; the "jet" must first be broken off, then the *sides* of each type must be rubbed by hand upon a stone to remove a portion of the roughness left in the casting. They are next set up in long sticks in single row, clamped firmly together, and a small plane passed over the bottom to remove the roughness caused by the breaking off of the "jet" making a small notch in the bottom of the type, which is termed a "foot nick ;" this gives each type two feet, and enables it to stand more evenly than it would if the bottom was solid or flat. After this is done, the line of type is clamped in such a manner that one *edge* is exposed in a metallic gauge so that a cutter or scraper can be passed over them, removing the roughness upon that edge ; they are then changed and reclamped, so that this process may be repeated upon the other edge. It is necessary that this operation of dressing the edges be performed when the type are in such a gauge that no more metal can be removed from one type than another ; because if more should be removed from the lower edge of one letter than the another, the type having the surplus removed would be lower in the line, and the line of printing thereby rendered uneven ; if more metal should be removed from the top of one type than another the line would be crooked in the opposite direction. The *sides* may be *rubbed*, because a small difference in the distance from one letter to another is scarcely perceptible in print. After this is done the finished type pass through an operation called "picking ;" this is examining each letter with a magnifying glass and throwing away all type which are imperfect on the face from bad casting ; such average about twenty per cent. of the type cast, and of course make the cost twenty per cent. more than it would be could all the letters be perfectly cast. After the type are finished as above, they have to be distributed by the printer, each little character and point being put into a separate compartment, and from these they must be taken by the fingers, one letter at a time, and placed in the composing stick in the order required by the words and sentences to be printed.

In relation to machines for doing this work, it is only necessary to remark that notwithstanding the vast amount of time, talent and money which has been expended in attempts to reach this end, none have, as yet, proved of any practical utility. It will also be readily seen that if a composing and distributing machine had been already perfected and in use, that it could not compete with this, because it would cost five times as much to furnish it with types which are constantly wearing out, and which must be as frequently replaced, as to furnish this machine with metal which never wears out ; and what is of still more importance to the reading public, it gives much more perfect printing, because everything printed from it is done with entirely new and clean-faced type.

Before giving a detailed description of the machine, we will remark that it was necessary at the first step to find a method by which all the type can be cast with proper faces, for if twenty per cent. of them had to be picked out after the proof reading, this expense would, to a certain extent, counterbalance the gain afforded as the general plan of the machine.

In this machine, as well as in the ordinary method of casting type, when the molds and matrices are in perfect order and closed to receive the metal, they are perfectly air-tight ; it is apparent that if the metal be injected into such a mold from the rear, that the air contained in it must be forced forward and form a bubble, and that there is great risk of this bubble appearing on the face of the letter, which must inevitably render it imperfect. This, type founders have not yet been able to avoid, because the metal is injected into an aperture below the foot of the type, at which point it passes through another opening into the type proper. In this machine this difficulty is avoided by casting the type with the foot nick ; this allows the shutting off of the metal on the top of that nick, so that any little roughness which may exist there does not injure the type. There is then the means of injecting the metal into the closed mold in such a manner that it strikes the matrice first, forces the air back and leaves the face perfect, the small amount of air not covered by the hot metal being disseminated into very minute particles toward the rear of the type where it does no injury whatever.

The machine occupies a little less room than an ordinary printer's case and stand ; it is composed of a single iron cylinder, mounted, and which revolves in a substantial iron frame ; from cams upon this cylinder all the motions are derived and they are all positive, nothing being left to the uncertain action of springs or gravity, and it should be impossible for the machine to make a single revolution without performing all the motions necessary to perfectly cast, dress, finish and set-up in line, any type which the will of the operator may require.

At the left end and in the rear of the machine is a small tank or font containing metal kept in a molten state by means of a small gas jet, burned upon the Bunsen principle, thus avoiding smoke and loss of heat. Immediately in front of this are the molds in which the body of the type are cast. These molds, by a small quantity of water contained in them, are kept at a uniform temperature under the well-known natural law, that no piece of metal containing water can be heated above 212° F. until the water is evaporated.

The face of the letter is formed in a piece of copper, in which it is punched and which is held in position while the metal is injected. As soon as the type is cast, this copper matrice is withdrawn from the face of the newly cast type and returned to its proper place, ready for use when again required.

These matrices are kept in frames standing across the centre of the machine at the right hand end, and are moved by means of two vibrating bars put in motion by the cams upon the cylinder ; each of these frames contains four matrices, two in front and two in the rear of the centre ; and each is furnished with a small rod pierced with four holes, in each of which is a pin standing over a corresponding pin on a finger key board, so that when the operator depresses a finger key, the pin in the bar of the frame is raised up into the path of one of the vibrating bars, which will engage it, and the matrice frame will be moved into such position that the matrice corresponding to the key depressed is left in the centre ; if the key depressed belongs to a rear pin, the frame will be moved forward ; if a front pin be depressed the frame will be moved to the rear. As soon as a frame is moved into this position a pair of traveling nippers passes through the centre of all the frames, excepting the one containing the matrice to be used ; and these nippers on their journey pick up the matrice from the frame thrown across the centre, carry it to the front of the molds, and they remain there stationary until the type is cast and the matrice withdrawn from it ; whereupon they return to their position at the right hand end of the machine, depositing the matrice as they return, in the place whence it was taken. They again remain stationary until the operator has depressed the key corresponding to the matrice next required, when they start and repeat the operation just described. All the keys are locked fast and none can be moved except at the proper instant while the traveler is waiting for the motion of the slides, and only one can be depressed at a time. If the operator does not depress a key a matrice without a letter will be carried to the molds and a space cast ; this answers a two-fold purpose ; it enables the operator to make the required spaces between words, by simply omitting to touch a key at the completion of each word, and prevents any accident which might occur by the operator neglecting to touch a key.

While the matrice is in front of the molds, the metal is injected by a pump, a valve is opened to admit it, and closed as soon as the mold is full ; the quantity of metal injected by the pump is sufficient to cast the largest type, and if a small one is to be cast the surplus, after the molds are full, prevents the piston of the pump descending

* Made by the American Type Machine Company, L't'd, 40 Broadway, N. Y.

further, as it is forced down by a yielding rod. The piece of metal which contain the matrices are made of different widths and each one opens the mold just the width required for it; the molds being closed after the casting of each type.

When the type is cast the molds are opened to admit a hook which removes the type, and carries it forward in a channel to a point at which it is received between the jaws of two vises, which seizes it on all four of its sides firmly. On an exact line with these jaws are four cutters, and as soon as they have grasped the type it is pushed through, and the cutters shave off all roughness which may be upon the type and deposit it perfectly finished upon the composing stick; as soon as this is done, it and all the preceding letters which may have been cast, are shoved along to the left upon the stick by a small piece of metal called the "setter;" the instant that the setter performs its work the next succeeding type is cast and in the molds ready for removal.

It may be supposed that the above is a process requiring considerable time, but if it be noted that all the operations are going on all the time, it will be seen that it can be done quickly, for while a matrice is being carried back to its place in its frame, and another being brought forward, the other part of the mechanism is engaged in removing a type from the molds, finishing and setting it up; thus no time is lost.

The time when the process herein described could be looked upon as an experiment has now passed. The results being obtained from it and which have been steadily produced during the last twelve months, are such as to no longer permit any doubt either as to its practicability or utility. It is now a fact, and as such will demonstrate itself to all who may be interested. For further particulars we refer to the circular published by the company, and which may be had its offices Nos. 40 and 42 Broadway, New York.

CONCERNING THE "REVIEW."

It may interest our readers, and surely will be pleasant to our advertisers, to learn that, under the present vigorous management of our subscription department, the list of our subscribers is rapidly increasing. From now until the close of the Centennial Exhibition, an unusually large number of extra copies of our journal will be carefully distributed by ourselves and by those who, having unusually clear and full illustrated descriptions of their manufactures, find it advantageous to *circulate each others' notices*. Undoubtedly it is more profitable for a dozen manufacturers to club together and take, each, a thousand copies of our journal noticing their exhibits or products, than for each one to have printed a thousand circulars, which people lose or throw away. *Verbum sap.*

DARIEN INTER-OCEANIC SHIP CANAL.

EDITORS POLYTECHNIC REVIEW.

Dear Sirs:—In compliance with your expressed wish to obtain a somewhat approximate idea of the cost of an interoceanic ship canal, without locks, across the Isthmus of Darien, I hand you this hastily prepared and decidedly crude memorandum of my views upon that subject.

In the first place, it is my opinion that the great difference between the rise and fall of the tides at the Atlantic and Pacific ends of the canal, would render it inexpedient to attempt to dispense entirely with the use of locks. Their number might, however, be limited to two tide-locks, one at each end of the canal. The rise of the Pacific tides along the shores of the isthmus generally ranges between from 16 to 20 feet, according to the locality; while along the Atlantic shore it is about one to two feet only. In other words, at a rough general average, the Pacific there rises say about 8 feet higher, and falls 8 feet lower than the Atlantic; the mean or average heights of the two oceans being about on the same level. Without having specially studied this branch of the subject, I should, however, be apprehensive that, without tide-locks, this difference in the heights of high and low water at its two ends would produce currents in the canal sufficiently strong to materially impede its navigation. Some, however, entertain a different opinion; and this question would have to be decided before a close estimate of cost can be made; because it involves not only the adoption or rejection of the locks, but also the depth to which the entire canal bottom would have to be excavated. With tide-locks this depth may be several feet less than without them.

Again, most of the surveys for an interoceanic canal have been made in too hasty and incomplete a manner to furnish data for an accurate estimate. To yield satisfactory results, surveys across the isthmus must, from the peculiar difficulties that attend them, consume much time, and vastly more money than has yet been devoted to any of them. Let us look first at the San Blas route. It crosses the isthmus at its very narrowest part, about 50 miles further down the coast than the Panama railroad. For a tolerably correct idea of its general features I refer you to my map of the isthmus, in the *Journal of the Franklin Institute*, January, 1871. The canal starting at the Gulf of San Blas on the Atlantic, would run nearly south to the mouth of the river Bayano or Chepo, on the Pacific. Two surveys have been made, one by the U. S. Government, and one by a party employed by Frederick M. Kelly, Esq., of New York; the Lesseps of the Isthmus canal. Although neither of these surveys is by any means final, still they appear to warrant us in making the following assumptions, namely, that the entire length of the canal need not *exceed* thirty-five (35) miles; nor the length of its tunnel be *more* than ten (10) miles. I also assume that a canal intended emphatically for a "*world's highway*," should not, where in earth excavation, have a less width at bottom than one hundred (100) feet; with full two hundred (200) feet width at the water-line; and thirty (30) feet depth of water; and that its side-slopes should not be steeper than two horizontal to one vertical. For the tunnel, assuming (as appearances indicate) that it will all be in rock. I take its width to be one hundred (100) feet to a height of forty (40) feet above water surface; thence diminishing to the top by a semi-ellipse. Extreme height two hundred (200) feet, or one hundred and seventy (170) feet above its top water line. I also assume that all the excavation except the tunnel will be in earth. This will certainly not be the case; but where it is in rock, the slopes of the cuts will be made steeper, thus reducing the *number* of cubic yards in about the same proportion that the *cost per yard* would be increased; so that the *entire* expense will be about the same in either case.

On the foregoing *maximum* assumptions, aided by the best judgment I can form from the published reports and profile, I conceive that the total cost of the San Blas route *cannot exceed* the following:

Ten miles of tunnel; 35 millions of cubic yards of rock at $5..... (This price includes the depositing of a comparatively small portion of the rock to form a complete rip rap facing for the protection of all the earth slopes of the canal cuttings.)	$175,000,000
Earth excavation and dredging; 100 millions of cubic yards at 75 cts.. (This price includes all clearing away of trees, and all other incidentals, as dredges, &c., &c.)	75,000,000
Two tide-locks, and their accessories.....	5,000,000
	$255,000,000
Contingencies, 15 per cent..... (Including harbor improvements, forts, light-houses, commissary and medical departments, roads, dwellings, stores, police, telegraphs, engineering, superintendence, &c., &c., &c.	38,250,000
Total,	$293,250,000

Or say, in round numbers, three hundred millions of dollars (without including interest during construction); or about three times the cost of the Suez canal.

It is not impossible, but on the contrary quite probable that a more detailed survey of the San Blas route may result in so improving it as to enable us to reduce this estimate to 275 millions of dollars, or even less. As to any reduction by diminishing the cross-section of the canal or of the tunnel, I can only say that I should consider it entirely inexpedient in a "*world's highway.*" Respecting the prices assumed per cubic yard, I do not regard them as more than sufficient, in view of the peculiarities of the climate, especially with respect to rain and health. Moreover the contingent expenses of the contractors in the construction of their buildings, making roads, clearing of forests, &c., will be very heavy; and during the rainy season, all kinds of work will be carried on under great disadvantages, such as cannot be realized by any one who has not experienced them.

Let us now glance at another route, namely, that by way of the River Atrato for about one hundred miles up to a point called the Vigia Curbarador; and thence for about thirty-five (35) miles across the country to the Bay of Cupica on the Pacific, in about latitude 6° 40′ north. See my Report and maps in the *Journal of the Franklin Institute*, years 1854—5; or my more correct map in the same journal, January, 1871.

On my return in 1852 (or nearly a quarter of a century ago) from my explorations for an inter-oceanic canal by way of the Atrato, I expressed my conviction (see my Report) that no ship canal between the two oceans would be found to be "*practicable in a practical sense*;" that is, that would pay a sufficient interest on its cost to recompense any company that should undertake its construction; and even at this day, notwithstanding the great increase that has taken place in maritime traffic, I see no reason to change my opinion. If such a canal is ever to be made, it should be by the co-operation of the governments of the leading civilized nations of the earth; and that, not with a view to any direct return in the shape of tolls (which probably would not, at least for many years, suffice for more than to keep the canal in repairs and in operation) but to the indirect advantages which would accrue to them all from the opening of so important a "world's highway."

In 1852 I proposed and laid down on my published map the route just referred to. As before remarked, its length of artificial canal would, like that by the San Blas route, be about thirty-five (35) miles. Its tunnel would, however, be but about five (5) miles long. It would require two or three locks, all of them at its Pacific end. From the imperfect data on the subject in my possession, I estimate its entire cost (including essential improvements at the mouth of the Atrato) at about three hundred millions (300,000,000) of dollars, or about the same as for the San Blas route; assuming the same dimensions and rates per cubic yard in both. As my explorations for an Atrato route covered a great extent of unknown country, and as the published results were founded entirely upon my own personal observations and opinions, it was deemed expedient, after a short interval, to send other engineers over the same ground, with a view to verify or disprove my report, as the case might be. It was gratifying to me to learn that they entirely confirmed my statements. Still more recently two distinct surveys by way of the Atrato have been made, under the auspices of the U. S. government. These surveys were conducted by full corps of engineers, amply furnished with the best of instruments, and other appliances conducive to satisfactory results. These surveys led to the proposition of two routes different from the one suggested by me in 1852. I am unable however to perceive that either of them is superior to mine; but in this I may be unconsciously actuated by that bias which so naturally inclines us to prefer that in which we feel a personal interest. I do not think that either of them would cost less than mine, assuming the same data in all three.

Again, a route has been suggested to run nearly side by side with the Panama Railroad. This would have very important advantages over any other, in the facilities for the transportation of men, materials and supplies; but my experience as chief engineer of that railroad during 1850 enabled me to see that that route, with tide-locks only, would for ten or twelve miles involve a tunnel and deep cuttings fully as expensive as those on the San Blas line; while for the remainder (about forty (40) miles) of its length the cost would be considerably greater than on the San Blas; the same dimensions of canal, and costs per cubic yard being of course adopted in estimating each.

Other Darien routes with tide-locks only, have been suggested; but I am of opinion that all hope of ultimate success must center upon one of the three just alluded to. Avoiding all reference to details, or any comparison of the merits of the several routes, I have confined myself to giving my views as to the great question, "*What will be the cost of a Darien inter-oceanic ship canal with tide-locks only?*" My answer is, that if made of the dimensions above assumed, I think its cost will be approximately three hundred millions of dollars. Yours respectfully.

JOHN C. TRAUTWINE.

Since writing the foregoing I see it announced that at the instigation of Mr. Gogorza, the Columbian government has authorized the survey of a route by way of the River Atrato and Tuyra, which promises to be altogether superior to any hitherto explored. I have no hesitation in predicting that the survey will result in disappointment.

Philadelphia, Aug., 1876.

THE ALISSOFF TYPE WRITER.

(RUSSIAN DEPARTMENT, MACHINERY HALL.)

There is no special reason why machines should, for ordinary purposes of letter-writing, supplant the fingers and the pen in the production of characters representing words. It is, perhaps, possible to produce machines to effect ordinary epistolary correspondence, to which individuality or identity should be given by the written signature alone. The increased legibility of such letters would be a great advantage to the community, while the mistakes, annoying and costly, which now accrue in consequence of ambiguity or absolute indistinguishability in hastily written characters, migh be entirely done away with.

But whether or not writing machines can or will supplant the quill for epistolary purposes, it is certain that there is a large and varied class of work, where execution by means of a machine producing regular and distinct characters at a rate approaching, if not surpassing, the speed of ordinary chirography, or even of good engrossing, would be more than desirable; would be imperative, were there, in general use, machines capable of effecting the desired result.

In this class may be placed all that work which requires to be of special legibility, as telegraphic messages, sermons, editorial copy, etc.; and also that where duplicate or manifold copies are desired, including military or civil bulletins or general orders, mercantile circulars and reports, etc., which need to be issued in haste, and at a low cost.

There evidently has been a wide and earnest demand for a writing machine for some or all these purposes. For a long time inventors have been racking their brains and emptying their pockets in producing, and exciting the community by promising, a perfect and superior substitute for penmanship. Those which have been offered in a tangible condition have been in construction complicated and easily deranged, and in operation imperfect; and yet some few of these have met with favorable recognition and one of them has been rewarded with extended sale and use.

Mr. Alissoff's machine, which is in operation in the Russian section, Machinery Hall, is of comparatively recent invention and manufacture. Being too late for early entrance at the Vienna Exhibition, it has received but little publicity, although it has been favorably recognized and adopted by the Russian Government. It is producing by far the best work in the exhibition, as regards beauty, regularity, and distinctness of characters; and has this advantage over any other of which the writer knows, that it produces both large and small letters ("capitals" and "lower case") of all the European languages, together with a full line of numerals, punctuation marks, etc.

The dimensions of the machine are about twenty-two by fifteen inches, including the stand and pedal. It is a very substantial and well made piece of apparatus, and evidently open to constant hard usage and even limited abuse.

A horizontal type-cylinder, whose base is towards the front, bears upon its convex surface six circular and parallel zones or sets of type, each zone containing 36 characters. Three of these zones represent Russian capitals, small letters, and numerals, etc.; the other three bear corresponding letters in the other European alphabets. This type cylinder moves longitudinally forward and backward, by means of a screw actuated by a crank in front of the machine. The base of the type-cylinder bears in front of it a dial with a series of three concentric circles divided into spaces marked with characters corresponding with the type on the periphery of the cylinder. The type-cylinder is revolved by a crank or handle upon its axis, and may be held at any point by a ratchet stop on the outer edge of the dial. By bringing the crank in front of any character on the dial, the characters corresponding to that division of the type-cylinder are brought to the top of the latter. In other words, if the index crank is brought between two radii of the dial, enclosing a Russian letter, a Roman letter, and a numeral or "point," there will appear at the top of the type-cylinder a Russian large and small letter; a Roman large and its small letter, a Russian and a Roman numeral or point. If the paper-bearing cylinder were above and parallel to the type-cylinder, and were brought into contact therewith, its point of tangency with the latter would be a straight line, on which, and also in the plane of axes, would be the six characters referred to; and if these were inked, the paper cylinder would receive impressions thereof; which would not be satisfactory. But Mr. Alissoff has very ingeniously placed his paper drum above, and at right angles with, the type cylinder; and when brought into contact, their contact or tangency is only a *point* directly in the line of *centres*, instead of a line in the plane of axes. By this means the types in only one circle at a time may be brought into tangency or contact with the paper, thus yielding its impression; but by the longitudinal shifting of the type cylinder (by means of the screw and crank before mentioned) any one of these circles or sets of type may be brought into use.

The paper feed is effected by a third screw and crank, at the right side of the machine, a bell indicating when the line is nearly finished.

Instead of using a ribbon saturated with an unctuous pigment, to give the impression (and which gives blurred characters, showing the texture of the ribbon), the types are inked by a narrow roller which revolves against a wider ink roll, and which inks only that circle of type which is being used. By revolving the dial crank in one direction only, no one character need be over-inked. We should say that the paper drum is brought against the type, and the impression given by a pedal, permitting of a hard, sharp, clear impression; the feed for spacing between the words is also accomplished by a pedal.

The paper feed corresponding to the varying width of the characters is effected by suitable mechanism in gear with the type cylinder axis, its *amount* being regulated in this way. The axis of the type-cylinder bears upon it, radially, six circles of screws, whose projection corresponds to the width of the types upon corresponding radii; the hight or projection of these screws determines the amount of feed given to a ratchet wheel by means of a pawl and of a lever lifted by these projecting screws.

The movements of the machine are all positive; there being no lost motion, the lines are wonderfully regular and parallel. Manifold paper may be used upon the drum to give from eight to fifteen copies; the work of impression being performed by the foot, this manifolding work is not fatiguing as when performed by keys operated by the finger.

Where a large number of copies is required, the impression is transferred directly to a lithographic stone, readily worked from without a press.

In our issue of July 15th, we gave a description of Mr. Alissoff's excellent mode of preparing music-*clichés*, of any size or style, by the aid of photography. This type-writer is used to advantage in inserting the words of songs between the lines of music.

We are informed by Mr. Alissoff that the Imperial Polytechnic Society of St. Petersburg has awarded him a medal for the process of preparing clichés for printing music, and also for the type-writer. A Russian governmental commission has, after careful examination and experiments in the war department, approved of the apparatus, and has expressed a willingness to introduce them into that branch of the government service as soon as they can be manufactured.

To sum up, the machine is strongly and handsomely built, and has a very wide range of work, which it executes in a manner superior to any other "type-writing" which we have seen. G.

REPORT ON THE BISMUTH MINE NEAR BEAVER, U. T.

EDITORS POLYTECHNIC REVIEW:

Dear Sirs,—While on a visit to the silver mines in Beaver County within the last two weeks, I made an examination of the bismuth mines situated twelve miles westerly from Beaver City, the county seat of Beaver County, and in pursuance of a promise made to our "mutual friend" Dr. C. F. Winslow, I herewith send you a short description of the mines.

These mines occur in a group of three or four apparently parallel veins, situated in the eastern foothills of a range of mountains called "Mineral Range" on the map. The nucleus of this range is a syenitic granite flanked by upturned beds of the silurian and devonian ages, and probably some portions of the subcarboniferous age.

The general course of the upturned beds and the lodes is N. 20° E. magnetic (variation 17° E) and the dip of the lodes, as well as the beds, vary from 60° to 80° west; but the general appearances are that the outcroppings have been pressed over to the east by the great central mass of the mountain; hence I infer that at no great depth the lodes and the conformable beds of altered limestone will assume a vertical position, and finally assume a dip eastward at a high angle.

The altitude at the mines, by barometrical measurement, is 6,450 feet above tide-water.

The formation in which the lodes occur is a highly metamorphosed magnesian limestone of the silurian age, of a grayish-white appearance, with streaks and bunches of a darker and greenish hue, somewhat approaching a serpentinous character, with lime garnets and bunches and seams of tremolite and its allied species.

I will designate the veins Nos. 1, 2, 3 and 4, beginning at the base of the hill and taking them in their order of occurrence going west up the mountain.

No. 1 is a small vein at the base of the steep part of the hillside. This lode is about one foot thick, with well defined walls, and showing bismuth ore in small streaks and bunches through the gangue stone. This may be an independent lode, but it is covered with *debris* along the line of outcrop, and there has been no tracing, by cuts or drifts, by which its true relation to the other lodes may be determined. It is possibly only a spur or offshoot of the main lode.

No. 2 is situated about 150 feet south-west of No. 1, on the steep side of the hill going up to No. 3. This is a somewhat stronger lode, of one to three feet thick, showing some very good ore in seams and nodules in the serpentinous gangue. This also has the appearance of being an offshoot of No. 3, but the exploration is not sufficient to enable me to say with certainty that it is so.

No. 3 appears to be the true central and persistent lode, to which the others are subordinate. The vein has been prospected by several open cuts along the outcrop, by which it is traced a distance of 800 to 1000 feet. The principal opening is a shaft some 40 or 50 feet deep, showing the lode to be six to ten feet in thickness. Two other shafts of less depth have been sunk on the lode further south. At the ravine, about 600 feet south of the main shaft, a tunnel has been driven north on the vein a short distance, which shows good ore in larger quantities than any of the other openings; and still further south, up the slope of the next ridge, another opening has been made, showing the lode continuing south.

No. 4 is a small vein of iron oxyd, 75 feet west of No. 3, carrying bismuth and silver with a variety of other minerals. This is a contact lode between the limestone on the east and the granite on the west side. It has not been much prospected, but the surface indications are favorable for a lode of persistence in depth and length.

This group of mines should all be worked from the same general opening as soon as a depth is reached that requires it. The surface ores can be extracted from each independently for considerable distances below the surface, but when the water line is reached all the workings should be connected to one point of drainage.

The mines are well situated for economical working—near the edge of a beautiful and productive valley that is intersected by several streams of water that unite to form Beaver River. Good roads up to the mines from the valley, an abundant supply of fuel for reduction purposes flanking the adjacent hills, and a mild climate favorable for operations all the year, make up a set of surroundings unusually favorable for a mining enterprise.

I am unable to give an opinion as to the commercial value of these mines, from the fact that I am not familiar with the methods and cost of reduction of bismuth ores. The percentage of ore contained in the entire lode is not large, but ranging, I should think, from one to five per cent. Some of the gangue rock contains scarcely a trace, while other portions are quite rich in the metal in the form of sulphide and oxyd of bismuth. The ore is, however, easily assorted from the waste rock, and proper concentration works would complete its preparation for the furnace. Of this part of the subject you are perhaps better able to give definite information than I am.

I have tried to give a fair description of the physical facts, so as to aid you in arriving at proper conclusions.

Very respectfully yours, J. C. CLAYTON.

Salt Lake City, June 30, 1876.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The Marguerite Bridge at Budapest.—The preparation of plans for this great work was undertaken in 1871. The choice of system adopted was left to the concurrent opinion of the engineers; but the Government imposed the condition that the openings should be 67 meters wide, and 14 meters high above the "zero" of the scale, so as not to hinder navigation. More than 35 plans were sent for competition; those of Ernest Gouin & Co., of Paris, were adjudged the best, and they were awarded a prize of 10,000 francs.

The contract for the construction was signed in the spring of 1872, and the work itself commenced in 1873; the formal inauguration of the bridge took place on the 30th of April last.

The total length of the bridge is 570 meters, and its width 17 meters; this bridge is formed of 6 arches, 3 at each side of the river, of which the openings are respectively 74·83 meters and 88 meters.

The centers have a radius of 135 meters; they are of wrought iron, and bear plates on which rest the Macadam and the wooden pavements.

The construction consumed 7,000,000 kilog. (15,400,000 lbs.) of wrought and cast iron, 40,000 cubic meters of masonry, among which were 4,500 cubic meters of granite, and 5,000 of other kinds of cut stone.

The iron-work for the centers was made in the shops of the Batignolles Construction Society, under the direction of Mr. Gouin; they were carried to Budapest directly by railroad, without transhipment. The granite came from the Bavarian frontier. In order to give the bridge a monumental character, the piers were ornamented with allegorical figures, three times the size of life; and with high candelabra of cast metal, bronzed.

The architect of the royal palace, Mr. Chabral Wilbrod, was charged with the architectural work of the bridge; the sculpture is by Thabard, and the cast ornaments by Durenne. The designs and calculations were made by Mr. Godfernaux; finally, the entire surveillance of the works at Pesth were confided to Mr. Fouquets, chief engineer of the house of Gouin & Co. [Trans. from *Moniteur Industriel Belge*, iii, 327.]

The Hell Gate Blast.—The great blast which was to have taken place on the 4th of July at Hell Gate, has been postponed until September. The excavation is completed, but the contracts for explosive materials have not yet been filled. The battery for exploding the charges will be placed near the edge of the pit; the operating room will be about 350 feet from it. The explosive materials used will be nitro-glycerine and its various compounds, in charges not exceeding ten pounds each, and placed at points where they will be most effective. Gen. Newton says that the water not only will act as a tamping or covering, preventing by its weight an intense report and shock, but that the enormous amount of heat generated from the liberated gases will spend its force in vaporizing the water, thus lessening the chances of marked agitation on the surface. It is not expected that much if any rock will be thrown above the water, except where the bed-rock may have weak spots or seams. In such cases the explosion will have more effect and throw the rock some distance in the air. The object of dispersing the nitro-glycerine is to effect a rending of the rock, so that it can be more effectually broken up by after blasts. The works cover three acres, and the amount of *débris* which will have to be removed is estimated to be not less than 30,000 cubic yards, requiring about two years' further work. [*Iron Age*, 8–3, 1876.]

A Second Cable between Europe and Australia.—Proceedings have been inaugurated for the purpose of establishing a second telegraphic cable between Australia and Europe. A deputation from the Sydney (New South Wales) Chamber of Commerce, lately performed the duty of representing to the authorities the necessity of duplicating the means of telegraphic communication between the two continents. The existing cable has now been interrupted for four or five weeks, and the closing of the last wool sales, and other matters affecting the colonies, had not been received. [Abr. from *Jour. of the Telegraph*, ix, 231.]

Progress in Japan.—We are informed that energetic measures are being adopted by the government of Japan for introducing the improved manufacture of iron into that country. With this view, two charcoal blast furnaces and other works are in course of erection, and it is expected that, by the close of the present year, twelve puddling and seven reheating furnaces, forge train, plate, rail and bar guide mills, with steam hammers, four different shears, saws, lathes, cranes and all other necessary appliances of the most modern construction will be in operation. [*Iron Age*, 8–3, 1876.

Underground Telegraph Lines in Paris.—C. Bontemps writes, that the total length of the underground lines in Paris is 116 miles. Of this total, 35¼ miles are laid in trenches, and 80¾ in the sewers. The cables are composed of 1, 3, 5 and 7 wires, mostly the latter, and the wires have an aggregate length of 2,266¼ miles. [From *Jour. of the Telegraph*, ix, 223.]

The Battle of the Gauges.—A comparison of the weight and cost of a passenger train on the Eastern, standard gauge, and on the Boston, Revere Beach and Lynn Railroad, narrow gauge, respectively, has been made. These two roads run nearly side by side and the carrying capacity of the two trains is practically the same. The heavy Pullman car is a disadvantage to the Eastern road in the comparison, as is also the baggage car, which is not required on the short line. A locomotive, baggage car, Pullman car and four passenger cars on the Eastern road give capacity for 230 passengers, weigh 138 tons, and cost $63,000; one locomotive and six passenger cars on the Revere Beach and Lynn road give capacity for 272 passengers, weigh 58 tons and cost $18,000. [*Eng. News*, iii, 242.]

Locomotives for Steep Grades.—The Bridgeport (Conn.) *Standard* of July 21 says: "Messrs. Copeland & Bacon, of this city, have constructed, under the supervision of Mr. Henry C. Walters and from his designs, a locomotive for use on inclined railroads, and we yesterday had the pleasure of observingits workings on the inclined track, built for the purpose of testing its capacity, near the water, just above the Congress street bridge. The engine stands upon an open platform and is worked by means of a strong wire rope which runs from one end of the track to the other, making several turns around two large drums on the engine, one above the other, the upper drum being connected with the steam power by means of a huge cog-wheel. The track on which the locomotive is now being tested rises one foot in ten, and the machine will do even better than that. Six of these locomotives are to be built by Messrs. Copeland & Bacon for use on a couple of mountain roads—one near Salt Lake and the other near San Francisco. They are four miles long and very much curved, and do a freight and passenger business, connecting two other railroads with each other. The locomotive works finely, going up hill or down with equal facility, and can be stopped anywhere on the steep plane without difficulty. When in actual use these engines will draw the cars up the hill and they will run down without assistance."

The Long Engine Runs adopted last winter on the New York Central & Hudson River Railroad (engines go through between Buffalo and Albany, 300 miles) have resulted in a notable economy in locomotives, the company having been able to lay up 42 of its stock of engines, notwithstanding a large increase in traffic. There are other considerable economies effected by it, as in fuel (saving heating up, cleaning, switching, etc.); and the company is altogether satisfied of the wisdom of the change. It is not pleasant for the men, who are compelled to be away from their homes a much longer part of the time; but the economy is such that there is no prospect that the practice will be abandoned for the old one. [*R. R. Gazette*, viii, 342.]

The Grand Canal du Midi.—A. Manier, the originator of the Grand Canal du Midi, lately noticed in our Journal, has replied to the article reviewing his scheme which appeared in the *Pall Mall Gazette*. He enumerates the sources of revenue to the canal, which are in brief as follows: From the estuaries of the Gironde and Aude he expects to reclaim 200,000 acres, which will yield a revenue of £1,200,000; from water for the irrigation of 5,000,000 acres, a net revenue of £500,000; 2,000,000 horse power from water will be available, of which he estimates the revenue on 600,000 only at £5 per H. P., or a revenue of £3,000,000; the trafic likely to pass through the canal in 1880, is 13,619,637 tons, two-thirds of which is bound for Mediterranean ports, on which there will be a saving of distance of 800 miles, and a revenue, at a very moderate rate, of £2,750,000; the rate borne by the landlords benefited by this improvement, in freedom from inundations, for which the South of France has become noted of late years, in the nature of an insurance on the property, will yield £250,000. From all sources a total income of £7,700,000 may be expected, or a net income of £7,000,000. This is about six times the gross receipts of the Suez Canal for the past year.

M. Manier paints the benefits to result to the whole of Southern France in an agricultural and manufacturing point of view, and also to commerce, in roseate hues. He promises to give his estimates of the cost of the scheme shortly, when we shall lay them before our readers.—[*Eng. News*, iii, 249.]

Steel Rails.—English Experience.—At the meeting of the Institution of Civil Engineers, held in London, England, May 23d, Mr. R. Price Williams read an interesting paper on "The Permanent Way of Railways." In 1865 the average life of iron rails in England was shown to be only three years.

In 1868 the half-yearly reports of the railway companies were required to be prepared according to a uniform system, and the distinction was then abolished between the maintenance and renewals. The average cost of the maintenance and renewals of the permanent way on the Great Northern Railway, during 1868, was £124 per mile of single line, and the net cost of relaying a single line with iron rails was £1371. Dividing the latter amount by £124, gave eleven years as the average "money life" at that time. In 1875, when steel rails were used, the cost of maintenance and renewals per mile of single rail was £184,78, and the net cost of relaying a single mile was £1626, giving a "money life" of only nine years, The diminishing of the "money life" during the last ten years, however, is attributable to the increased labor in preserving the substructure of the road, the cost of maintenance amounting to four times the amount of renewals. So, when the nine principal railways of Great Britain were considered, it was found that the "money life" was least on the Lancashire and Yorkshire Road, being only 6.66 years; while on the Southeastern it was greatest, being 10.50 years. The average "money life" of the roadway on these roads was 7.61 years during the last ten years; and in 1875 it was 7¾ years. The author estimated that every year's increase of the "money life" of the road was equal to an addition of one-fourth per cent. interest on the capital, and hence was an important matter. Of course, since the life of rails depends upon the amount of traffic passing over them and the speed of trains, no conclusion of value can be arrived at without a knowledge of these points, and they have not yet been clearly set forth. During the last ten years 85 per cent. of the mileage of the Great Northern Railway had been renewed, and the average life of rails was nearly 16 years; making the average cost of renewals per annum £139.55 per mile of single line. Steel rails were first used on the London and Northwestern Railway about the year 1862, and, since they are not worn out, the estimate of their probable duration is based upon the wear as compared with the tonnage passing over them. It was shown that a wear of one sixteenth of an inch corresponded on the London and Northern Railway to a traffic of 9,370,777 tons. In the Maiden Lane tunnel a wear of one sixteenth of an inch of the rail corresponded to a varying traffic of 5,251,000 to 31,061,000 tons. On the Great Northern Railway steel rails laid near Harnsey, in 1866, showed a wear of fifteen hundredths of an inch for 66,547,000 tons, equivalent to 27,727,000 tons for the wear of one sixteenth of an inch. In the Metropolitan (Underground) Railway, which was opened in 1863 and equipped with steel rails, the greater part of the rails had been worn out, and in some cases thrice renewed, owing to the enormous traffic. In the tunnel it was found that rails subjected to continuous damp wore out much sooner than those which were kept dry.

The character of the rails was also discussed, and the conclusion arrived at that the hammered ingots were inferior to those which were simply "cogged" before rolling.

In conclusion, the author of this interesting paper expressed the hope that in future steel rails would be made of such uniform quality as would insure as an average the maximum quoted above, or about 30,000,000 tons for a wear of one sixteenth of an inch. With such material the average life of a steel rail would be about 300,000,000 tons of traffic. Of course, the varying endurance of the rails mentioned depended very much upon the qualities and constituents of the rails used; and it is quite probable that the experiments now in progress will determine pretty exactly the constituents of rails which will give the most wear for a given cost.—*Scientific American Supplement*, ii. No. 33, 517,]

The Chesapeake and Ohio Canal Company have completed their new outlet locks from the canal to the Potomac River. The mode of operating this outlet is entirely new, being the only work of the kind in this country, and is considered a great feat in engineering. The elevation to be overcome is forty feet. Under the old system it would require eight locks and not less than fifty minutes to pass a boat through. With the present arrangement the boat is passed directly from the canal into a large caisson filled with water; the caisson resting on trucks, run down an incline plane to the river in less than six minutes. The weight of caisson and boat is about 350 tons. The work constructed under the supervision of Mr. W. R. Hutton, engineer, has already attracted the attention of many of the best engineers in the country. [*Hyd. Eng.* i, 133.]

Deepening the Channel at the Mouth of the Mississippi.—The form of river channels is the result of the action of the water conveyed, upon the banks and bottom of the streams.

There are mainly but two operations which produce all the results to be considered. The first is the excoriation or washing of the bottom and sides of the stream by the current; and second the deposit of solid matter thus loosened and carried down.

Strong currents loosen and carry down the stream the particles of sand, gravel, or mud, that it most actively impinges upon, and as the velocity of the current is reduced, the larger and heavier particles are deposited. If the channel of a river can be contracted and confined in a narrow width, and especially if it be maintained in a straight line, the velocity of the current will be increased, and thereby the sedimentary deposit checked; and if the velocity is sufficiently great at the bottom of the channel, the loose particles at the bottom of the channel will be moved forward, and a deepening of the channel will take place. That Capt. Eads has succeeded thus in deepening the channel at the mouth of the Mississippi, seems to have been attested by the passage of large steamers, with a draft much greater than could have passed previous to the improvement.

It is probable that Capt. Eads will encounter a greater difficulty when he comes to deal with the deposit that will take place at the point where the current, by the loss of velocity, must drop the solid matter and form new bars.

If the velocity of the current can be maintained to a point where it is projected into a gulf current that will carry off the solid matter, then he will have accomplished a *permanent improvement.* [*Hyd. Eng.*, i, 133.]

Westinghouse Brake in Belgium.—*La Revue Industrielle* says that the results have been so satisfactory with the experimental train furnished with the Westinghouse brake which has been running for three years on the State railroads of Belgium, that orders have been given to extend its application with a view to its general use on these lines.

Obstructions to Mississippi Navigation.—In our last issue we alluded to the obstruction to navigation of the Mississippi River, caused by the numerous bridges which span it. We have learned since that a commission of engineers met in St. Louis during last week, for the purpose of considering remedies for the evil, convened by the following order from Headquarters Corps of Engineers, which explains itself:

WASHINGTON, D. C., Juue 22, 1876.

By authority of the Secretary of War, a board of engineer officers, to consist of Col. J. N. Macomb, Col. J. H. Simpson, Maj. F. M. Farquhar, Maj. C. R. Suter, and C. J. Allen, will assemble at St. Louis, Mo., on the 7th day of July, 1876, or as soon thereafter as practicable, to inquire into the expediency of causing sheer-booms to be placed on the upper end of all or any bridge piers on the Mississippi River for the better security and convenience of navigation for rafts and timber, and will make special reports in each case, as provided by act of Congress of March 5, 1875. By command of Brig. Gen. Humphreys. THOS. LINCOLN CASEY,
Lieut. Col. of Engineers.

The inquiry will include all the bridges from St. Louis to St. Paul. Not the least among these obstructions is the St. Louis Bridge. Although a noble arch bridge of three 500 feet spans, admirably adapted for crossing mountain chasms or any place where headway is not an object, it proves a great obstruction to navigation, not only from insufficient headway at the crown, but from the fact that, for purpose of steamboat navigation, the arch diminishes the available span of sufficient height for up-river boats to comparatively narrow dimensions, and most of the lower-river boats are utterly precluded from passing. The rivermen have just cause for grumbling, and the projectors have no cause for complaint to the recommendation of an officer of engineers, to build a canal around the bridge through East St. Louis and put in a draw. Now that the mists raised over what was really a great engineering feat, in a constructive point of view, have cleared away, it is seen that the plan recommended by the thirty engineers convened in St. Louis to consider "plans for a railway and highway bridge," would have been much better for all concerned. If the bridge was to be built to-day, it would, probably, be constructed in two spans on the Fidler type of rigid chain suspension bridge, similar in most respects to the Point Bridge, now being erected by the American Bridge Co., at Pittsburg. [*Eng. News*, iii, 242.]

Heating a Trunnion Coil Fifty-six Tons Weight. at Woolwich Arsenal.—It was brought out of a furnace whose mouth, when it gaped, was like the opened west end of a cathedral. Nebuchadnezzar's burning fiery furnace must have been nothing to it. The coil had been in fifty hours, and had been heated at a cost of somewhat over five-and-twenty tons of coal. Aided by two cranes, each capable of bearing 100 tons, and a pair of tongs weighing, I should think, six tons at least; an army of firemen, who to such work seemed dwarfed to Lilliputians, swung the coil on to a 750-ton hammer block, that had in turn for its foundation one hundred 50-feet piles 14 inches square. Here the coil stood erect like the peak of the Jungfrau transmuted into gold in the setting sun, as, like myself, many, I trust, of my readers have seen from their hotel at Interlachen. Cyclops and his men were mighty fellows, but all their hammers put together would seem but a toy compared with that hammer which came thudding down upon this immense coil. The hammer head weighed forty tons. With steam behind it, it has a force equal to 2000-feet tons. Feet tons, I need hardly explain, means tons possessing the force given to them by a one-foot fall. The hammer stood there at an elevation of some fifty-six feet. Most delicately, like Poe's raven, it came tap, tap, tapping; for these blows, mighty though they were, seemed but taps upon the brow of this iron Jungfrau, so firm and erect did the coil stand beneath them, nevertheless, you could see the effect. The glowing interstices in the twist gradually lessened; but even after the British Cyclops had expended all the power he chose to put forth, the outlines proclaimed the mass to be a coil still. The coil had not only to be compacted into a tube with comparatively solid sides, but it had to be kept perfectly true in its center. From the opposite side of the hammer was now, therefore, reared, by the aid of the crane and another pair of gigantic tongs, a steel mandrel, which the delicate attention of our friend Cyclops with his tap, tap, tapping soon forced into the centre of the coil. His ribs thus blown out by the indigestible mass which he had been made to swallow, the 56-ton coil, now heavier by many a ton by reason of his meal, must have his sides well belabored. For this purpose, the surfeited coil is again clutched by the huge tongs and sent sprawling upon the block. Here Cyclops began again thumping away at the poor fellow as he lay prostrate; this time helping very considerably to close up his ribs.—*American Manufacturer.*

—From time to time the idea of making Paris, France, a seaport, is agitated. The river at Paris is between 60 and 70 feet above the sea, and the distance in a straight line but 120 miles, although by the course of the stream it is 210 miles. To straighten the river somewhat and dredge it out to seven feet would cost 13,000,000 francs, and to ten feet about 24,000,000 francs. This of course would be available for ships of moderate tonnage only.—*Eng. News*, iii, 250.]

MINING, METALLURGY AND MINERALOGY

Bismuth is found in considerable quantities in Utah. In Bingham Canyon, traces have been found in a number of mines, while in the Socrates mine, situated on Sheridan Hill, some fine specimens of sulphide of bismuth or "bismuth glance" have been found that assayed as high as 32 per cent. pure metal. This, however, was an extraordinary occurrence, and further investigation proved the deposit to be of very limited extent. A number of deposits of small area occur in this Territory, some of them of surprising richness, but the evident insignificance in quantity makes the working of the deposits out of the question. One notable exception, however, exists in the bismuth mines of Beaver County, called the Starr King and San Francisco mines. This deposit gives every indication of being a permanent vein and has had considerable money spent on it in development. The two mines adjoin on the same vein, which has been exposed to the depth of several hundred feet. From the surface to the bottom of the shaft a broad belt of ore is seen varying from 3 to 8 feet or even wider. This ore is extremely hard, being filled with coarse garnets and impregnated with arsenic. The bismuth is evidently a sulphide and is found in the ore in a proportion varying from 3 to 12 per cent.

This deposit, so far as we know, is the largest and richest in the world; the mines in Saxony, from which is procured the principal quantity annually consumed, yielding never more than ¾ or 1 per cent., and that only in connection with other metals. The market price for bismuth is now about $1·85 per lb. [*Utah Weekly Miner*, i, 32.]

The Mineral Fields of New South Wales are more extensive than most persons imagine. The proclaimed gold fields alone embrace an area of about 16,000 square miles, partly reserved from sale by the government for the purpose of public mining for gold. The total production of gold to the end of 1874 was £36,535,246, and the total value of gold coined at the Sydney mint to 1874, was £35,857,000. The approximate area of the coal fields is 24,840 square miles. The total quantity of coal raised up to 1874 was 12,387,279 tons, valued at £6,655,328. In 1874 they raised 1,304,567 tons. The approximate diamond mining area is 500 square miles, in which territory is included noble opals, ruby, sapphire, topaz, zircon, etc. The approximate area of lead and silver is 500 square miles. The approximate area of kerosene shale is 660 square miles. The total production of this substance in 1874 was valued at £261,414. The approximated area of the iron ore deposits is 1,400 square miles. The tin fields cover an area of 6,250 square miles. The total production of tin ore to the end of 1874 was £866,431, and the exports in that year were valued at £484,354. The approximate area of the copper mining region is 3,360 square miles. The total production of copper to the end of 1874 was £807,476, and the exports in that year were valued at £320,444. [*Saward's Coal Trade Journal*, xii, 30.

—The extensive steel works which have been in process of erection by the Vulcan Iron Works Company some time past, at St. Louis, were completed Tuesday, Aug. 1st, and made their first blow. The works are for the exclusive manufacture of Bessemer steel rails, and are asserted to be the largest in the country.

—Gold mining in Georgia is being vigorously prosecuted, and it is said, with very encouraging results.

MISCELLANEOUS.

The Fair of the American Institute.—The Forty-fifth Annual Exhibition of Arts and Manufactures, under the auspices af the American Institute will be opened, according to announcement on the sixth of September next, at the Institute Building, corner of 63d street and 3d Avenue, New York city. From the announcements that have been published, it appears that the authorities design that the impending exhibition shall present unusual attractions to exhibitors, to which end they have, among other things, made unusual preparations for the accommodation of exhibitors, and offer the inducement of increased awards and a special gold medal for articles of eminent merit or novelty. It is anticipated that the great influx of visitors to the East at the present season, will make the exhibition in question exceptionally valuable. All inquiries should be addressed to the General Superintendent, American Institute, New York city.

New Treatment for Cholera.—A recent article in *Chamber's Journal* gives detailed accounts of the successful use, in Asiatic Cholera, of hypodermic injections of chloral hydrate and other sedatives, instead of giving stimulants through the stomach. The theory is that the heart and arteries are in a state of spasmodic contraction and require relaxation by sedatives.

—A well-known French earthenware manufacturer has just devised a new mode of decoration for private dwellings and public buildings. Instead of applying the decorated faience to the wall, he proposes enamelling the stone itself, by putting up a light scaffolding and using the blow-pipe instead of the oven. The advantages of the scheme are principally cheapness and durability. The experiments tried show that the process is less expensive than separate plates, and the decoration is calculated to last as long as the stone itself. The architect of the Louvre, M. Lefuel, has given his entire approbation to the process, and means to take the first opportunity of applying it under the inventor's supervision.

—The *French Association* for the Advancement of Science will meet this year at Clarmont-Ferrands, under the presidency of M. Dumas.—The Hell Gate blasting, it is now affirmed, will take place on the 15th of September.

Farming in California.—Some idea to what vast extent farming is carried on in California, and some other Western States, may be formed from the following item in one of our exchanges: "Plowing in unbroken furrows six miles long can be seen in Fargo, California. The teams start in the morning and make one trip across an entire township and back before dinner, and the same in the afternoon, making 24 miles' travel every day." It would seem that the steam plow ought to find a place in such a region.

Consumption of Wood by the Comstock Mines for 1876.—The consumption of wood on the Comstock and in the mills and other works connected with the mines for this year, it is estimated, will amount to about 260,000 cords, worth at $12 per cord, $3,120,000. Of this 200,000 cords will be shipped by rail, 20,000 by the Carson river to its destination and 20,000 cords will be taken out of the river at points between Empire City and Dayton and hauled by teams to the mines and mills. The amount of wood sent down from the mountains through the flumes has been yearly increasing, while the amount of wood floated down the Carson River is steadily increasing. The amount of wood floated down the river in 1874 was 140,000 cords; in 1875 it was 75,000 cords, and this year, all told, it will not exceed 60,000. The reason for the decrease of the amount coming down the river is owing to the fact that the pine forests are each year cleared off to a greater distance from the stream and its tributaries. Eventually the standing forest trees remaining will be at such a distance from the river that it will be cheaper to build flumes through which to send down the wood than to haul it to the stream and then drive it. It is estimated that the amount of lumber and mining timbers which will be shipped to the Comstock during the year will be between ninety and ninety-five million feet. Nearly all of this will come by rail.—[*Exc.*

A Cruise around Lake Nyassa, Africa, developes the fact that the lake is much larger than its discoverer, Dr. Livingston, supposed. It extends to 9° 20′ South latitude, and the cruise around it occupied a month.—*Eng. News* iii, 249.]

Colors for Confectionery and Food.—The police of Paris have directed that the following substances be employed for coloring articles of food or confectionery : Blue : indigo and its derivatives, Prussian blue. Red : cochineal, carmine, Brazil wood, lake orchil. Yellow : saffron, Avignon yellow berry, quercitron, fustic, turmeric. Green : mixture of Prussian blue and logwood (Campeachy wood). Violet : mixture of carmine and Prussian blue.

The use of the following pigments is prohibited : Oxide of copper, blue copper salts, red lead, vermilion, chrome yellow, gamboge, white lead, Schweinfurt and Scheele's green (Paris green).

For coloring drinks they recommend Curaçoa logwood ; for absinthe, soluble indigo blue with saffron ; for blue liquids, soluble indigo blue, Prussian blue and ultramarine.

We notice that, singularly enough, aniline colors are omitted from the list of prohibited colors.

Poisons.—On April 21, the Austrian Government published a decree in regard to the traffic in poisons, declaring the following substances to be included under the term poison : 1. Arsenic and all its compounds. 2. Chlorides and oxides of antimony. 3. Oxides and salts, including the chlorides, iodides, and bromides, of mercury. 4. Ordinary phosphorus. 5. Bromine. 6. Prussic acid, and preparations containing it, as also all cyanides, with the exception of those containing iron. 7. All violently active preparations made from poisonous plants and animals, or manufactured artificially, such as the alkaloids, curare, cantharides, etc.

Mechanical Value of the Diamond.—Steel and new alloys are now manufactured of such density as to necessitate the discovery of new means of working them, especially where truth and accuracy are required. Steel-cutters may not hold their edge a sufficient time to traverse the full extent of a face on substances so intensely hard, therefore it is important that a substitute should be found of such durability as to retain its cutting edge intact, producing the same truth and accuracy of surface at the end of the work as at the commencement. Such a tool, when known to exist, will, no doubt, prove a valuable acquisition, and be eagerly sought for. To obtain such a tool the Societe d'Encouragement pour l'Industrie Nationale, of Paris, are offering in 1877 a prize of 3,000 francs for the artificial preparation of compact black diamond (commonly called bort or carbonate,) for obtaining thereby a powerful means of action for working hard metal substances, etc.

Among the comparatively recent mechanical arrangements, are many in which the diamond is made to play an important part ; in fact, there is no mineral or metal that can equal it in its diversified and prospective field of application. Diamond drills, for instance, have proved valuable prospecting mines, many being now used for the latter purpose in England, on the continent of Europe, and in America. Again, the diamond is now also being largely used in America for channeling and quarrying stone, as well as working and carving it by rotary and traversing drills or bits of various sizes and shapes, armed on their surface with black diamonds or carbonates, which are shaped with sharp angular or curved cutting edges ; these bits are made to traverse and rotate at a very high rate of speed, following the interior line of a templet, producing thereby beautiful patterns of paneling of any design or depth desired in stone. The rapidity with which the work is done, and the smoothness of finish, are something marvelous. These points are also used effectively for trueing hardened steel faces, such as dies, etc., also chilled iron and paper calender rolls.—*Scientific and Mining Press.*

Prizes Offered by the Netherlands Scientific Society, Haarlem, 1876.—Prizes are offered for essays on the following subjects :—(1) Complete experimental study of the possibility of decomposing water by a Daniel's cell. (2) The meteorological and magnetical phenomena which can be shown to be in connection with the solar spots. (3) Mixtures of hydrogen and carbonic oxide being ignited in the eudiometer with a quantity of oxygen insufficient for complete combustion, there remains a part of the two combustible gases, and the quantities of water and of carbonic dioxide formed are in the ratio of simple multiples of their molecular weights. Repetition and investigation of these experiments is asked for. (4) The society asks that the researches of Mr. Lockyer concerning the difference of the spectral rays of calcium be extended to the other elements. (5) Collection of the experiments relating to the existence of *bacteria* in contagious diseases, with original researches. (6) Construction of a simple instrument for measuring temperatures above 350 degrees C. in degrees of the air thermometer. (7) Investigation into the influence which the different colors of the spectrum exert on the lower animals.

CENTENNIAL NOTES.

PAPER CAR WHEELS.

During the last few years special attention has been called to the mode of constructing wheels for railway vehicles, and experience has shown that defects, more or less serious, exist in most of the wheels at present in use.

It has been found desirable to make wheels either of an elastic form, or of an elastic material, so as to diminish vibration, with a view to lessen the wear and reduce the liability of breakage, or, in case of breakage, to prevent the tire leaving the body of the wheel.

Fig. 1.—Front Surface of Wheel.

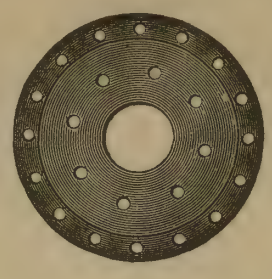


Fig. 2.—Interior Paper Surface.

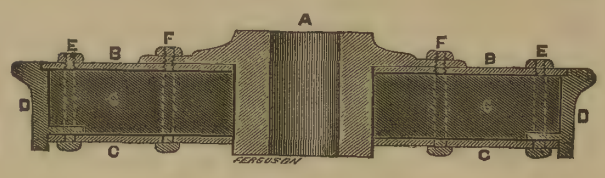


Fig. 3.—Sectional view of Wheel.

REFERENCES.—*A*, axle ; *BB*, outside iron plate ; *CC*, inside iron plate ; *EE*, outer row of bolts ; *FF*, inner row of bolts ; *GG*, paper block.

The American Paper Car Wheel Company, of Hudson, N. Y,, shows at Column E–65, Machinery Hall, specimens of 30, 33 and 42 inches wheels of its manufacture. These wheels have steel tires made with an inside flange and a cast iron hub. On each side of the hub and tire, wrought iron or steel plates 3-16 inch thick are bolted, and the space between the plates is filled with compressed, or rather condensed, paper. This paper is made of straw boards $\frac{1}{3}$ inch thick, pasted together with paste made of rye flour, and first made into sections about $\frac{1}{2}$ inch thick. These are subject to a pressure of about 400 tons for about five hours, and are then dried with hot air. These sections are then pasted together in the same way, so as to get the requisite thickness, about $3\frac{1}{2}$ inches, and are again pressed and dried. They thus form a disk, which is turned off and the tire forced on with a pressure of about 150 tons. The plates are then bolted to the inside and outside of the wheel with $\frac{3}{4}$ inch bolts. An old wheel is exhibited, "one of the first paper car wheels ever made. It has run under a Pullman car 312,900 miles without the tire being turned." One of the wheels is shown with a portion of the plates and paper disk cut away, so as to show the inside structure. One of the paper disks is also exhibited ; and if a separate tire and hub were shown, the exhibit would be complete.

The wheel centre, G, is formed of a homogeneous, solid mass of compressed paper ; on each side of the centre G, there is a wrought iron plate, B and C, and the boss, A, fitting tight in these two plates, is forced by hydraulic pressure securely into the centre, G, the latter being forced by a great pressure into the tire, D. A web, or flange is rolled on the inside of the tire, fitting into a rabbet on one face of the centre. An outer ring of bolts, E, passing through the two plates, B and C, the flange of the tire, and the centre, G, securely fastens the tire to the wheel. An inner ring of bolts, F, passing through a flange on the hub, A, the two plates, B and C, and the centre, G, secures the hub A, in the wheel ; and the hub is connected to the tire, D, through the outside plates B and C, thereby preventing the hub turning around in the wheel itself.

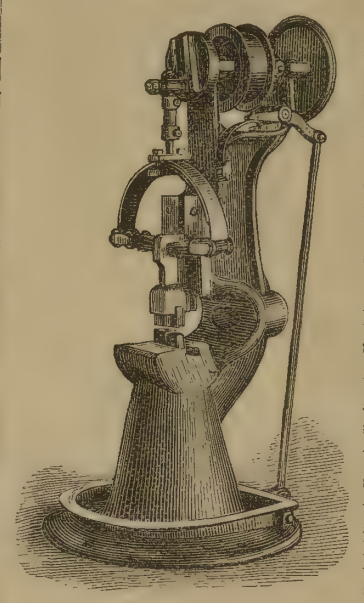
The elasticity of the centre is secured by leaving a small annular space between the circumference of the two plates B and C, and the inner side of the tire D, and by elongating the bolt holes through the web of the tire, thereby transmitting the weight from the hub to the tire solely through the elastic centre. The internal flange of the tire not only materially strengthens the tire, but in case of fracture, tends to hold it to the body of the wheel.

The makers claim for their paper car wheel :

"1st. That it is absolutely safe. The manner of construction, and the materials, render impossible any breakage which would endanger locomotive or car. The centre between the hub and tire is made of paper compressed under a pressure of 350 tons, and is thus made extremely solid, and being a homogeneous mass, without grain, it will not disintegrate under the constant jarring or pounding to which car wheels are subjected, as in the case with iron or steel. This centre is made to perfectly fit the hub, which is pressed into it by a pressure of 25 tons. The tire, which has a web or flange extending down into the paper, is put on with a pressure of 230 tons. On both sides of the paper are thin plates of boiler iron, and the whole is bolted together as shown, the outer row of bolts passing through the web of the tire. The nature of the paper being such that the bolts do not become loosened as in wood, but have been found perfectly tight after running over 300,000 miles.

"2d. That it is an elastic wheel—the paper block to which the steel tire is bolted, being from its nature somewhat elastic, the tire has a sort of cushion to rest upon, and consequently springs in proportion to the blow, thus being much easier upon the rolling stock than any other wheel.

"3d. That it is an economical wheel. By its elasticity it is a source of great saving in the matter of rails and cars. It will run more miles with less care than any other wheel in use. Wheels are now running that have made over 386,400 miles, and less the slight wear of the tire, are still perfectly good and sound."



THE "DEAD STROKE" POWER HAMMER, built by the Hull & Belden Co., Danbury, Conn., is shown in operation in Annex No. 1 to Machinery Hall. Its construction and operation may be readily understood from the annexed cut. The main shaft, driven from above, drives the hammer by means of a slotted crank-disk. The ram or hammer has heavy guides, and receives the stroke through the intervention of a powerful leaf spring, between whose free ends the guide-head is attached by stiff and heavy leather straps. The action of the hammer is at once positive and cushioned. It may be started at any portion of the stroke. The clutch and treadle may be seen in the cut. The machine is compact, simple and efficient.

EDITORIAL CORRESPONDENCE.

PHILADELPHIA, August 12, 1876.

EDITOR POLYTECHNIC REVIEW :

DEAR SIR :—In your issue of August 5th you describe a system of water works patented by Mr. John N. Poage, of Cincinnati, consisting of upper and lower reservoirs ; the former for domestic use, the latter for fire service only. Those of your readers who, like myself, inhabit the neighborhood of Green Street near Fairmount Ave., Philadelphia, have a very *dear* and vivid remembrance of an occasion in the summer of 1875—about the 4th of July—when this very new system was accidentally tried in Philadelphia, as follows : Our Water Department, without any previous notice, turned on the new reservoir at George's Hill, which was at a considerably greater altitude than the one previously connected to our service pipes in that neighborhood. The consequences were disastrous. Some pipes burst ; all the spigots began leaking ; some kitchen-boilers exploded ; many water-backs of ranges were cracked and ruined ; one party had his kitchen range blown clear away, nearly killing the cook ; all the water-closets having ball floats were disarranged ; some houses having tanks in the attics were completely flooded, and many costly frescoed ceilings utterly destroyed. Imagine this happening in the middle of the night, and not in one locality, but over a whole city, and you will have some idea of how the "*new system*" would work in practice. Experience is such an expensive teacher, that its lessons cannot be too closely studied, or too widely disseminated.

Very truly, F. B. M.

[In reply to the above, the editor would simply say that the fact of a heavy water pressure having been put upon a system of supply-pipes intended for a moderate pressure only, and having produced costly and disastrous results, is no argument against the adoption of a system securing to a city, in time of need, a heavy water-pressure available for fire-extinguishing purposes, at a less cost than where the greater head is constantly maintained. Mr. Poage's system simply allows of the pressure on the domestic service-pipes, etc., being reduced to a minimum during more than 99-100ths of the time. As a matter of course, the pipes should be strong enough to withstand the higher pressure ; the use of the lower reservoir relieves them from a high-pressure, and increases their durability. This very city is one of several hundred towns which have been subjected, through low water pressure at fires, to worse loss than the bursting of water-backs.

The Holly, Birkenbine, or any other system of "direct-supply" puts on the household pipes a greater pressure during fires than at any other time.

Furthermore, very simple pressure-regulators may be attached, with the Poage or any other variable pressure system, in order to keep the pressure on old or weak pipes constant and moderate. G.]

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, AUGUST 26, 1876 NO. 8.

THE NATIONAL STEAM PUMP.

HYDRAULIC ANNEX, MACHINERY HALL.

This pump is made under the patents of A. J. L. Loretz. The manufacturer is Mr. William E. Kelly, at the National Iron Works, in New Brunswick, N. J.

The pump and engine are of the direct acting kind, the pump being worked directly from the steam cylinder in a line with the axis of the latter. The steam and pump cylinders are connected together by three brace rods, which keep the strain that exists between the two cylinders in a direct and central line; the makers claiming that this plan is preferable to that of connecting the steam and pump cylinders by a bed plate, on account of the latter springing from the unequal strain thrown thereon, thereby binding all the working parts in proportion as the strain between the two cylinders increases.

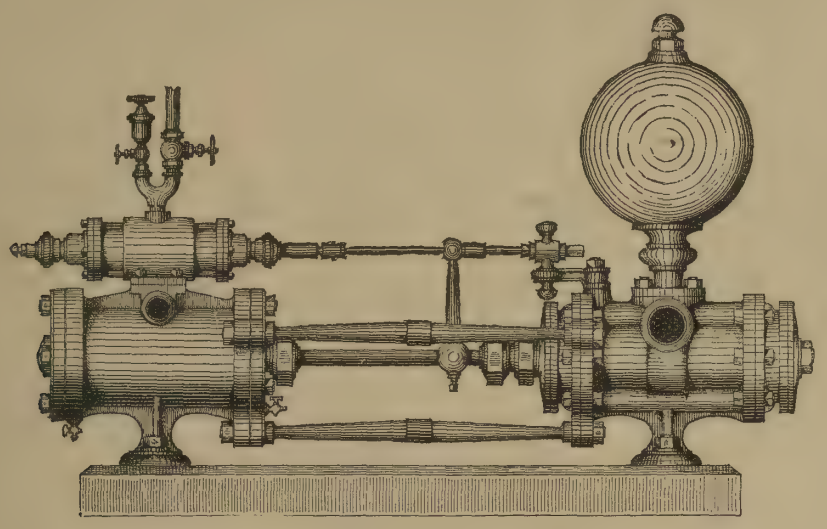


Fig. 1—THE NATIONAL STEAM PUMP—GENERAL VIEW.

The steam and water pistons have packing rings, actuated by the pressure within their respective cylinders. The valve gear, as is usual in such engines, consists of an auxiliary motor which operates the valve of the main engine when it is in an inoperative state—that is, when the main engine is at the point of reversing—and consists of the usual number of elements, namely, an auxiliary steam cylinder with its piston and valve for the purpose above mentioned. These elements are simplified by being embodied in some of the parts already performing their functions, as will be seen by reference to the sectional view. The main steam valve is the well-known piston valve, performing with its opposite ends or faces the function of auxiliary piston, and the main valve stem the function of auxiliary valve in combination with the main valve chest, which also performs the office of an auxiliary cylinder.

The main valve stem, when the engine is running fast, carries the valve to its proper position, being secured to the valve by a swell or auxiliary tappet, confined in the centre of the bore of the main valve by two heavy steel springs, secured at each end of the valve between a counter bore and a collar screwed to a shoulder, there being a certain amount of play or lost motion between the swell and springs, in order that the stem may be moved for the admission and expulsion of steam into and from the auxiliary cylinders without moving the main valve or auxiliary piston.

The auxiliary valve has four slots cut in the stem and combined with passages in the valve chest bonnets, communicating with auxiliary cylinder and main valve chest. The valve is so arranged that the main engine, through the medium of the tappet lever on the main piston-rod, closes the main valve and auxiliary piston, but

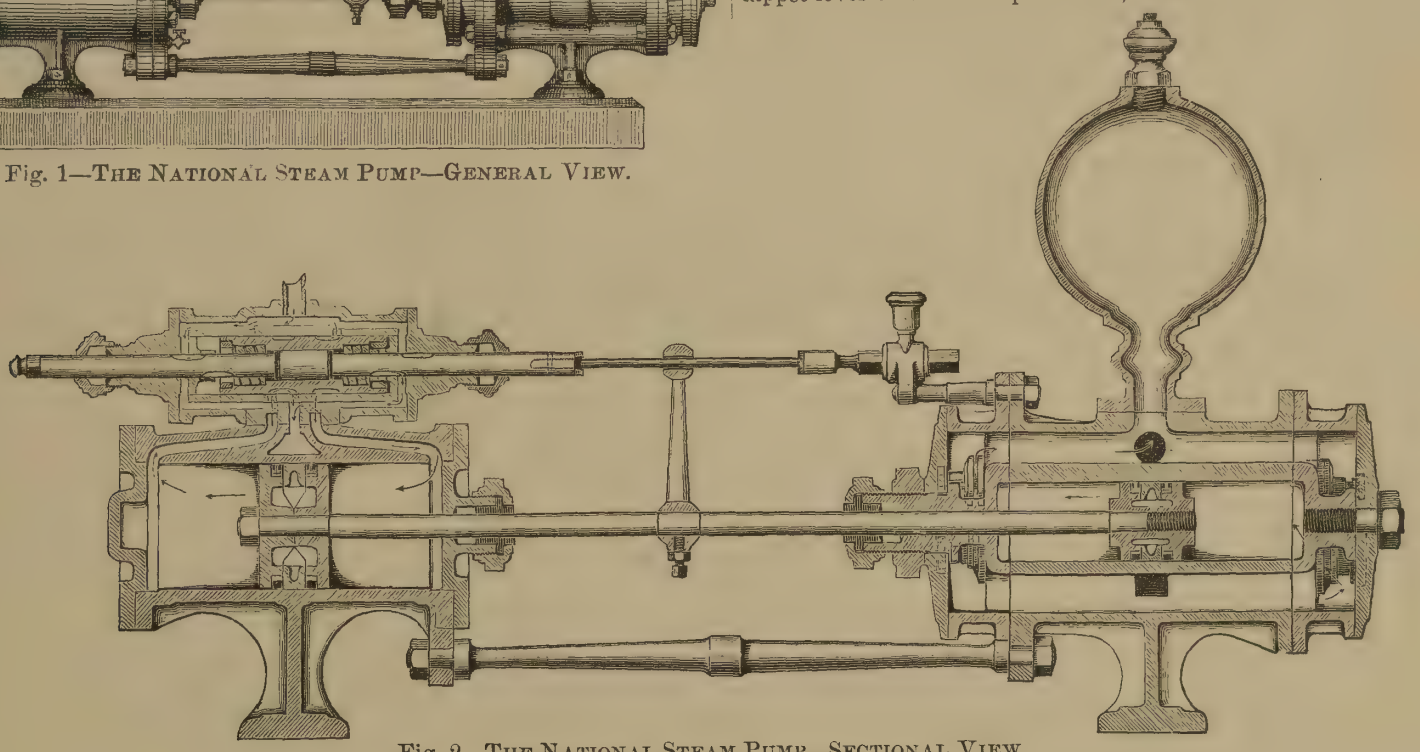


Fig. 2—THE NATIONAL STEAM PUMP—SECTIONAL VIEW.

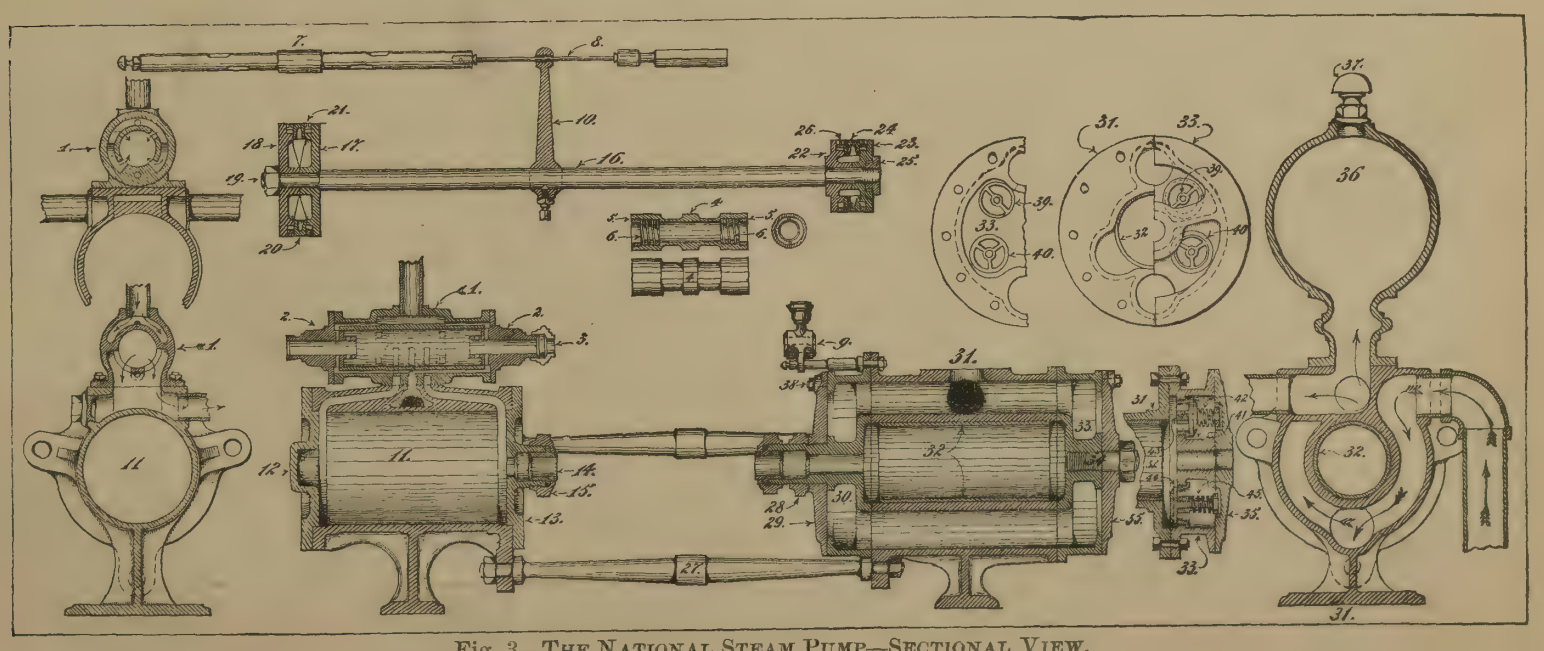


Fig. 3—THE NATIONAL STEAM PUMP—SECTIONAL VIEW.

before the valve is entirely closed the auxiliary valve or slots in the valve stem, combined with the ports in the valve chest bonnets, admit or emit steam on the respective opposite sides, closing the main valve entirely and also opening the same on the opposite side; thereby admitting and emitting steam into and from the main cylinder for a return stroke.

The movement of the main valve and auxiliary piston from end to end of the valve chest is checked by the same springs that secure the valve stem to the main valve. The valve and auxiliary pistons are driven to and fro by two combined actions, being started by the main engine and afterwards assisted by the auxiliary steam motor before mentioned, and still further aided by a spring which is kept compressed by the steam during the stroke of the main engine until the valve is started for the return stroke, when the spring is released; the valve being locked in position by the pressure of the steam until ready for the return stroke.

The advantages of this arrangement are evident. In most valve gears the blow of the valve against the chest heads is checked by cushioning on steam in various ways; some by closing the exhaust ports before the valve reaches its destination, others by admitting steam, while still others have steam or air cushions attached to the valve gear; all of which have their defects, the greatest being that the water entering these cushions chokes up those parts and renders them inoperative just when the pump is most needed.

Engineers are well aware that when a pump is started or is running very slow, the pipe is filled with the water of condensation, and the greater the length of the pipe the greater the condensation. It is claimed that this pump will run as well with water as with steam; consequently if the pipe is full of water the effect would be that of a hydraulic engine, and this pump may be used to raise water above the source of supply in order to operate other machinery.

In the construction of a good pump there should be as few angles as possible for the water to pass in entering and leaving the cylinder, as every angle adds to the labor of the motive power. Of this pump it may be said, with one exception, that the water lies at the door of the cylinder chamber, for the suction and the delivery valves are in the heads of the cylinders, each having an area proportioned to that of the cylinder, never less than one quarter in the smallest pump made; there being also no space left between the piston and heads, which in other pumps exists in the form of clearance and ports leading from suction valves to pump cylinder and thence to delivery valves. The construction of the motive valve gear is such that the strokes of the pump are of uniform length, there being hardly any perceptible difference whether the pump is running slow or fast.

The one exception above mentioned consists in the suction pipe being connected at the top of the cylinder in lieu of connecting directly with the bottom passage. This arrangement may have its disadvantages, but it is claimed that they are more than compensated for by the result obtained in the working of the pump; a siphon being formed which keeps the suction valves continually immersed in water. The instant the piston moves, the water enters the cylinder and follows the piston, the belt acting as a siphon to draw the water up the suction pipe, the pump being always charged and consequently drawing water without difficulty.

The valves are easily accessible; by removing a bonnet at each end of the cylinder —requiring the removal of but one nut—access may be had to any of the valves and they may be removed and replaced, with their seats. Every passage may be examined and access had thereto.

WROUGHT IRON TUBULAR ARCH BRIDGE OF KING'S PATENT, AT TOPEKA, KANSAS.

The great and increasing use of iron in various forms in all departments of construction, is so marked a feature of the present age, that no surprise is excited when a new application, or an improvement in an old application, of this material is announced. In almost every department of the arts iron is gradually superseding wood for constructive purposes, and almost daily one hears of some new application of this wonderful material. But in no department of mechanical construction has there been such a universal tendency to extend the employment of iron as in bridge construction. The nature of the material peculiarly fits it for use in structures of this kind, and multitudes of iron bridges now span the rivers of Europe and America. The great need in the United States, where wood soon decays and money is scarce, was wrought iron bridges, which could be built within the often limited means of the counties and villages compelled to use highway bridges. After considerable experience and experimenting with different forms of bridges, Mr. King adopted a bowstring trussed girder as the most economical and strongest form in which iron could be put for resisting the peculiar strains of a bridge subjected to highway travel, and he has evidently had no reason, after an experience of 19 years, to change his mind. The use of cast iron was discarded by him at the commencement, except in small unimportant members, where the strain is exclusively compressive; wrought iron being the material used. Over 3500 of these bridges have been erected in the 19 years since they were first introduced. The Topeka bridge, shown in the full-page engraving, is of the bowstring trussed girder type. Its extreme length is 900 feet, divided into six spans each of 150 feet in length. The roadway is 18 feet wide in the clear; there are two sidewalks, each 5 feet wide in the clear. Each span of the superstructure consists of a plank and timber flooring supported by two trusses of wrought iron. The trusses are composed of wrought iron arches, wrought iron chords, uprights and diagonals. The truss arches consist of two channel irons as top and bottom, and two boiler plates as sides, of the rectangular tube, which is the shape of the arch. The channels and plates are securely fastened together with rivets, hot pressed and hot riveted. All riveted surfaces are brought into close contact, so as to exclude moisture when painted. The heads of rivets are formed centrally on the shanks, and the spherical snap which forms the head is driven until the edges are brought down to the surface of the iron. The extremities of the arches are formed into shoes of cast iron, resting on the abutments or piers with a flat bearing from heel to toe, and have a firm connection with ends of chords by thread and nut connection of the same sectional area as in the main chords. The ends of the arch joints are planed or dressed to form a uniform or perfect bearing; and the joints lap at least 30 inches. The chords are composed of two flat bars under each arch. All chord connections have enlarged heads, containing the same sectional area as in the main chords. All chord pins are turned, and are not more than 1-64 inch less in diameter than their pin holes. There are no holes in the chords except at the connections, as above. The posts or struts are formed of round or star shaped iron; those at the ends of the truss being less in diameter than the longer ones at the centre of the truss. The upper ends of the posts pass through the centre of the arches, with thread and nut connection; the lower ends pass between the lower chords and through connecting blocks of cast iron. Screw nuts, both over and under the chords, hold the posts securely in place, making the same adjustable, and obviating the necessity of cutting holes through the chords, thereby reducing their sectional area. The diagonals cross each other, two in each of the quadrilateral panels of the truss; their ends pass obliquely through the arch and connecting blocks, and have screw nuts at end for adjustment. To give lateral steadiness to the structure, there is a pair of diagonal sway rods in each of the panels of the bridge. The system of sway bracing commences at the feet of the arches, passing diagonally from that point to the first post from the end of the bridge; starting from that point they continue through entire length of structure. The side braces connect with the arches at the lower flange, and are placed opposite each other; they pass down and cross at a proper angle, so as not to interfere with the roadway or sidewalk travel; and they connect at the foot with iron beams. The beams are placed on and bolted to chords. The head bracing over the floor is high enough to leave a clear headway of about 14 feet, and consists of panels of gas pipe iron as struts, and of rods lateral braces. The pipe iron struts are connected with arches by cast iron posts set upon and bolted to the same. The ends of the struts pass through the top of the posts, and are adjusted by a nut on each side; and are securely trussed by the lateral truss rods before mentioned. The sidewalk railing consists of cast iron posts three feet high, and of rods passing through and properly adjusted for expansion and contraction. The floor joists are of pine and extend across the roadway and outside of the arches, to support the sidewalks; which are on the outside of the arch trusses. The floor-plank is of oak lumber laid diagonally; and the sidewalk of plank pine laid lengthwise. The hub plank is of pine.

The builders state that the Topeka bridge, after its construction, withstood a stampede of 550 head of Texas cattle, which rushed upon the bridge from the hill at one time, and completely covered both roadway and sidewalk at the same time, and surged and jumped about as only cattle when frightened do.

These bridges are built by the King Iron Bridge and Manufacturing Company, of Cleveland, Ohio. The Company has a paid-in capital of $225,000, which is amply sufficient for their business. We name a very few of their principal bridges: Pittston, Pa., 1048 feet. (four of the spans being from 200 to 220 feet each); Waltham, Mass., 406 feet; Cleveland, Ohio, 910 feet; Elyria, Ohio, 415 feet; Chicago, Ill., 306 feet; Binghampton, N. Y., 560 feet; Columbus, Ohio, 378 feet; Fort Laramie, Wyoming Terr., (for U. S. Government), 400 feet.

For the engraving we are indebted to our contemporary, the *Aurora Brazileira*.

ON ANILINE.

BY PROF. HERMAN POOLE.

From time almost immemorial the purity, brilliancy and durability of the Tyrian purple has been celebrated; and since the art of making was lost, attempts without number have been made towards its reproduction. Time and money, in fact whole lives and fortunes, have been spent in its unsuccessful search, and then, just as it is rediscovered, forth steps a new claimant to the public favor and supplants it. That Tyrian purple is now known may seem to some an unwarranted assertion; but the difference between murexid and the true purple is so slight that they may be considered identical; both are the same marked color, both have practically the same composition, and both may be obtained from the same source—a shell-fish, Murex.

The investigations leading to the discovery of murexid were undertaken principally for the end attained, but the investigations leading to the discovery of the aniline colors primarily had no such object in view. Murexid, although obtained more advantageously by artificial means, was and can be obtained from the shell possessing its color, and was known or suspected to exist in and to be obtainable from that source when the search began. With aniline the case is entirely different; it was not suspected and was only accidentally discovered during a search for something else, and when discovered remained a chemical rarity for years. Who could have imagined that such a series of brilliant colors would be obtained from that black, disgusting looking substance, coal-tar? Yet, this is but one of the results of the study of those men who devote their lives to the increase of knowledge and seldom receive or expect any pecuniary reward, leaving that to their more fortunate successors.

A brief recital of some of the discoveries bearing on these colors may not be out of place. About the middle of the eighteenth century a volatile gaseous "spirit" was obtained by Dr. Clayton from coal by distillation. In 1792, Murdock made the first attempt at utilizing this "spirit" for illuminating purposes. In a few years the use of coal gas as a source of light became general. In 1826, Unverdorben obtained a liquid from indigo, and, from the facility with which its salts crystallized, called it "crystalline." In 1835, Runge obtained a violet from some of the products of coal-tar by the action of chloride of calcium. In 1840, Fritzsche, who gave the name aniline to a liquid he had previously obtained, discovered that chromic acid turned this liquid blue; other chemists confirmed this observation. Professor Hoffman investigated the various properties of crystalline, aniline, etc.; showed that they were identical, and kept the name aniline, the name by which it is now usually known. In 1856, Perkin obtained his violet, and in 1859 the industry became fully established. Since then the discoveries and modifications have followed in rapid succession.

For a perfect understanding of these colors and an appreciation of the labor expended on them, some knowledge of the crude materials is necessary. At the present time all are familiar with the production of coal-gas, and know how the bituminous coal is put in a large retort and heated, a gas charged with heavy matters passing off, and a large portion of these matters condensing in an iron pipe, called the hydraulic main. These matters run off into wells, from which they are taken and sold under the name of coal-tar. This is a greenish or brownish-black semi-liquid substance and is of a very complex nature, the mere recital of the proximate elements of which

WROUGHT IRON TUBULAR ARCH BRIDGE, OF KING'S PATENT, AT TOPEKA, KANSAS.

it is composed being quite enough to excite astonishment, and to attempt to count them would be almost futile; yet all of them are composed of the same five elements, and the large portion of them consisting of but three. This tar was for years a perfect nuisance to the gas companies and the neighborhood, they being obliged to pay for its removal from the premises. But what a change! At present the demand is almost up to the supply and is steadily on the increase. So that what was formerly an important item of expense is now as full an important one of gain.

Being of such a complex constitution, it will be readily seen that, on distilling, a vast variety of products are obtainable. But the one called benzol or naphtha is the only one used in the aniline manufacture. The pure article is not required, the presence of toluol, a somewhat similar substance, being necessary, as will be shown further on. The commercial article contains the necessary mixture and is the one used. As usually obtained, this is a nearly colorless liquid, of a peculiar, agreeable odor and is very inflammable. It may be obtained in a solid state on exposure to sufficient cold, and boils at about 176°. Its specific gravity is about ·85, being somewhat lighter than water. If this liquid be added to warm fuming nitric acid it is dissolved, and on cooling or dilution a yellowish oil separates, which is known as nitro-benzol or essence of mirbane. It has a sweet taste and an odor resembling that of the oil of bitter almonds. In fact, it is sometimes called artificial oil of bitter almonds and used as a substitute for the genuine, in soaps and many cheap perfumed preparations. For the past few years its use seems to have become almost a mania among the soap men, as even the laundry soaps are now scented with it. It may be worth mentioning that it has one advantage over the natural oil, in not containing prussic acid. It is one of a large class of substances obtained in organic chemistry by the substitution of nitrogen and oxygen for hydrogen; most of them are explosive, as gun-cotton or nitro-glycerin.

Nitro benzol is the commercial source of aniline at the present time, although other sources are possible. The most common method of procuring it is Bechamps' method, and depends on the action of nitro-benzol with iron and acetic acid. About equal portions are used, the mixture being made in an iron vessel and kept cool, as the reaction is usually violent. In a short time the mixture has changed to a semi-solid mass consisting of acetate of iron and aniline. On distilling, aniline passes over, accompaned by several other substances. That passing over at a temperature from 340° to 380° is the best. A second distillation over lime gives a commercially pure article. Various other reducing agents may be employed. It was formerly obtained from indigo, and from this it took its name, *anil*, being the Portuguese for indigo.

As thus obtained it is usually a sherry-colored liquid (if pure it is colorless), having an agreeable odor and an aromatic burning taste. It is a little heavier than water and dissolves in that menstruum, alcohol or ether. It solidifies at —40° and boils at 360° (when pure.) It leaves a transient greasy stain on paper. It forms salts with acids, most of which are colorless if anhydrous. As mentioned above, the addition of chloride of calcium produces a blue coloration, and change of color is produced by any of the metallic salts rich in oxygen. It is on these reactions that its detection in the laboratory depends, and some of them form the foundation of the manufacturing processes for the colors.

Of all the organic bases this is the most important, both to the chemist and to the technologist. Upon the facts developed in its study, the theory of organic bases in chemistry is built, and upon the innumerable changes of color (almost every conceivable shade being possible,) derived from it an entirely new branch of dyeing and color printing has been founded. A glance at the array of its colors presented at any modern exhibition will satisfy one of the truth of the above. In 1867, sixty different colors were known, and the chemical formulæ of most of them determined. Now, the number is far greater, and is steadily on the increase.

In 1856, Perkin, a young English chemist, was experimenting with a view to obtain quinine artificially, and as is very often the case, failed in obtaining what he sought, but found instead a substance of far greater value. He discovered mauve, or Perkin's violet. It is known under innumerable names, Perkin's violet, mauve, violine, rosaline, tyraline, imperial violet, etc. etc.; many of them being names applied to the same substance by different makers, others being given to different shades of color. The mode of preparation now is substantially that introduced by Perkin. His method consisted in acting on sulphate of aniline with bichromate of potash, both disolved in water. They are well mixed and allowed to stand for some hours. The dark colored sediment is collected, washed with water, dried, exhausted with naphtha and then with alcohol. From this solution mauve is obtained as a beautiful bronze-like substance, hardly soluble in water, but freely so in alcohol and acetic acid. It may be purified, if necessary, by a tedious process, not resorted to in the arts. Other processes are possible, but this is the one most used. Hoffman's violet, prepared from alcoholic solutions of aniline and iodide of ethyl, is by far the most brilliant of the violets, and is used to a considerable extent, but not as largely as the regular mauve. To attempt to give a description of the color would be futile, and all of us are familiar with it. It occurs in our wall paper, our carpets, our clothes, and even in our ornaments of all kinds. It is so common that, were a description possible, it would be entirely unnecessary. It was this color that claimed the attention of dyers and led them to ignore the claims of Murexid. The brilliancy of the color may be inferred from this.

(*To be continued.*)

A GENTLE HINT.

Some of our correspondents who are Centennial exhibitors but not subscribers to the REVIEW, and who are sent, for verification before publication, proofs of our articles describing their manufactures, request us to send them "a few copies of the number containing the article;" but enclose no currency therefor. We shall generally send the copies, if we think that they will be placed where they will extend the influence of the paper; but would suggest that if such parties desire to see how their notices appear in print, they should subscribe to our journal; and if they wish "a few copies for distribution," they shouldenclose a few times eight cents to pay for them.

THE INDUSTRIAL APPLICATIONS OF ASBESTOS.

The visitor to the Exhibition will scarcely fail to have observed, in Machinery Hall and in the Main Building, the exhibits of asbestos and the products manufactured therefrom. These exhibits will go far to modify the views of many of the well-informed, who have entertained the conviction that this remarkable substance would never attain to any prominence in the useful arts; for their number and variety and apparent excellent adaptation for their respective uses, are not only highly gratifying to the utilitarian, who beholds in them a hitherto practically waste or useless substance turned to good account, but likewise to the general public, to whom they present the attraction of being adapted to meet a number of practical wants and requirements.

There are several exhibits of asbestos products in the Exhibition; the largest and most interesting, however, is that of Mr. H. W. Johns, of New York City, to whom belongs the credit of being the first to attempt the utilization of asbestos for industrial purposes on a large scale in this country.

Before proceeding to the description of the products in question, it will be of interest to introduce the subject with a few preliminary remarks upon the nature and history of this substance.

The name asbestos (from the Greek *asbestos*, unconsumable), is applied by mineralogists to a fibrous modification of tremolite, or actinolite, and other varieties of hornblende, and to similar fibrous varieties of the mineral pyroxene. In its physical properties, the asbestos presents considerable variations; for although the fibrous quality, which is characteristic of it, is common to all of its modifications, the degree of compactness of the mineral, and the texture and disposition of the fibres present considerable variety, sometimes admitting of easy separation with the fingers, and at others compacted into hard and stony masses, requiring considerable mechanical manipulation to effect their disintegration. The fibres are often as fine as flax, in the more delicate varieties called amianthus, and have a satiny lustre, while again, the fibres are so interlaced that the fibrous structure is not apparent, when it receives the names of mountain leather, and rock or mountain cork. The former occurs in flexible sheets or laminæ, resembling leather, and the latter has the feel and nearly the texture of cork. Many other minerals, it may be added, have varieties which present a fibrous structure similar to asbestos, and are therefore designated, from this peculiarity, as asbestoid or asbestiform. Chemically considered, asbestos is composed of silicate of magnesia, silicate of lime and protoxide of iron (or manganese). It is quite indifferent to the action of most chemical reagents and resists the action of fire. The mineral occurs generally in association with the older or crystalline rocks, and although it may not be called common, it is by no means of rare occurrence, being found in deposits of considerable magnitude in many parts of the United States, and no less abundantly in other countries.

The very peculiar properties of asbestos, namely, its eminent fibrous quality, and its indifference to the action of most chemical agents and to fire, have long been known, and attempts to turn them to account for various useful purposes are recorded from the most ancient times.

The long, fine and flexible fibre of the mineral suggests, at first glance, the possibility of producing a woven fabric from it, and accordingly, we find numerous allusions to the fact that certain of the finer qualities of asbestos were manufactured into cloth by the ancients, who were acquainted with its incombustibility. This cloth, we are told, was sometimes the material used for napkins, which could be cleansed by throwing them into the fire. It was also employed, because of its indestructibility by fire, for enveloping the bodies of the dead before cremation, and for the wicks of lamps in the ancient temples, and is said to be yet very commonly employed for this purpose by the Greenlanders.

It is only, however, within the last few years, that the effort has been made to systematically utilize this substance upon the commercial scale, and the number and variety of the products which the ingenuity of the manufacturer has succeeded in obtaining from it are exceedingly interesting, and promise that the material which has been known for ages as a sort of mineralogical curiosity, may speedily attain to considerable importance in the useful arts.

To return now to our description of the asbestos products exhibited at the Centennial Exhibition, we may confine ourselves practically to the exhibit of Mr. Johns, which contains representative examples of everything of this nature that is elsewhere displayed, besides offering several unique and interesting specialties of manufacture.

The asbestos roofing exhibited by Mr. Johns we shall describe in first order as being perhaps the most directly useful and practical of these products. This material comes in the form of a flexible sheet resembling leather, and consists, first, of an upper layer of asbestos-coated felt, beneath which is a layer of acid and waterproof composition into which asbestos enters as an ingredient, then follows a canvas lining, then another layer of the fire and waterproof asbestos composition, and lastly, a Manilla lining.

We find, in a recent issue of a well-informed contemporary, the following reference to this product and its mode of application. "These materials are compressed into a sheet resembling leather, about one-tenth of an inch in thickness, and produced in continuous rolls about 40 inches wide and containing each 200 square feet. The weight is 50 lbs. per 100 square feet, or about 1-10 that of gravel roofing. The manner of applying the rolls to the roof consists in merely tacking the fabric to the boards, which is done on steep or flat roofs with equal facility. The last process is to go over the laid roofing with a prepared coating of suitable color. This is made of asbestos in a flocculent state, mingled with silica paint body and other ingredients. It is applied with a brush, and forms an elastic waterproof felting. For large and important edifices, an asbestos concrete may be applied by means of a trowel, and in lieu of the above described coating. The advantages claimed for the roofing are that it forms a water-and-air-tight smooth surface, which is a good non-conductor of heat, and is practically a resistant of fire; that it is adapted to all climates, and is unexcelled in durability and cheapness by tin, slate, or shingles of the qualities ordinarily used for this purpose."

As a covering for steam-pipes and boilers, asbestos has been suggested and employed in several different ways. One of the methods employed by Mr. Johns consists, briefly described, in applying a cement mortar containing asbestos in a flocculent condition resembling paper pulp, with some cementing compound or mortar, directly upon the boiler or pipes, which compound, when it has set, forms a good non-conducting and fireproof

covering for the same. A modification of this plan consists in applying first to the pipe or boiler a turn or two of a lining felt containing asbestos as its chief constituent, and applying the cement upon that. The application of the felt has the advantage of allowing for the expansion and contraction of the metal, thus avoiding the cracking of the coating; and likewise aids, not inconsiderably, the insulating power of the same. It may likewise be mentioned that an asbestos-lined hair felt is made, which is affirmed to be specially adapted to the requirements of marine and locomotive boilers, the asbestos lining serving as an efficient protector to prevent the charring of the other. A thick but flexible board of asbestos has also been manufactured and recommended for the same purpose. The non-conducting properties of these asbestos coverings is affirmed to be excellent. As a steam packing, asbestos has been highly recommended, and been considerably introduced. For this purpose its indifference to the influences of the highest temperatures, and its self-lubricating quality—which it possesses almost to the same degree as soapstone—render it peculiarly well fitted. For this purpose the long fibres of the disintegrated mineral are securely covered with a braid; and the product is manufactured in coils of convenient length for steam packing. The results of its use under the severest conditions are affirmed to be admirable.

Another class of exhibits are the paints, in which asbestos, ground to an impalpable powder, forms the body. These are shown of a great variety of shades, and are declared to possess very superior qualities for outside work, being not liable, from the tenacity of the body, to crack or scale.

Several other articles and products in which this substance plays an important part are exhibited, among which we should mention fire-proof coatings and paints for wooden structures, shingle roofs, etc., fire, acid, and water-proof cements, sheathings, linings, lubricators, etc. The asbestos board, before alluded to, is worthy here of special mention, from the fact that it is specially adapted as a fire-proof lining for the wood work of compartments, etc., in the interior of buildings, steamships, etc., in fact for any situation where a flexible covering of a fire-proof character is desired and can be applied. It may be covered with paper in the usual manner, or decorated according to taste when once in place. There are doubtless a great number of situations where the employment of a protecting covering of this nature would materially lessen the risk of fires, and we deem this product of asbestos worthy of the attention of the fire insurance interest.

The other products, such as paper, cloth and the like, although they possess a general interest, have not as yet sucured any material utility; on the whole, however, the display of asbestos products forms one of the most interesting exhibits at the Great Exhibition. W.

THE "REVIEW" AS A "MUTUAL BENEFIT AGENCY."

A few members of firms among our advertisers have expressed themselves as being annoyed by constant solicitations for personal subscriptions by the canvassers belonging to our subscription department. Others cheerfully submit to such momentary interruptions; seeing in them an indication of the thorough canvassing of the field, resulting in a rapid and steady increase in our subscription list, and a consequent and enhanced value of advertisements on our cover pages.

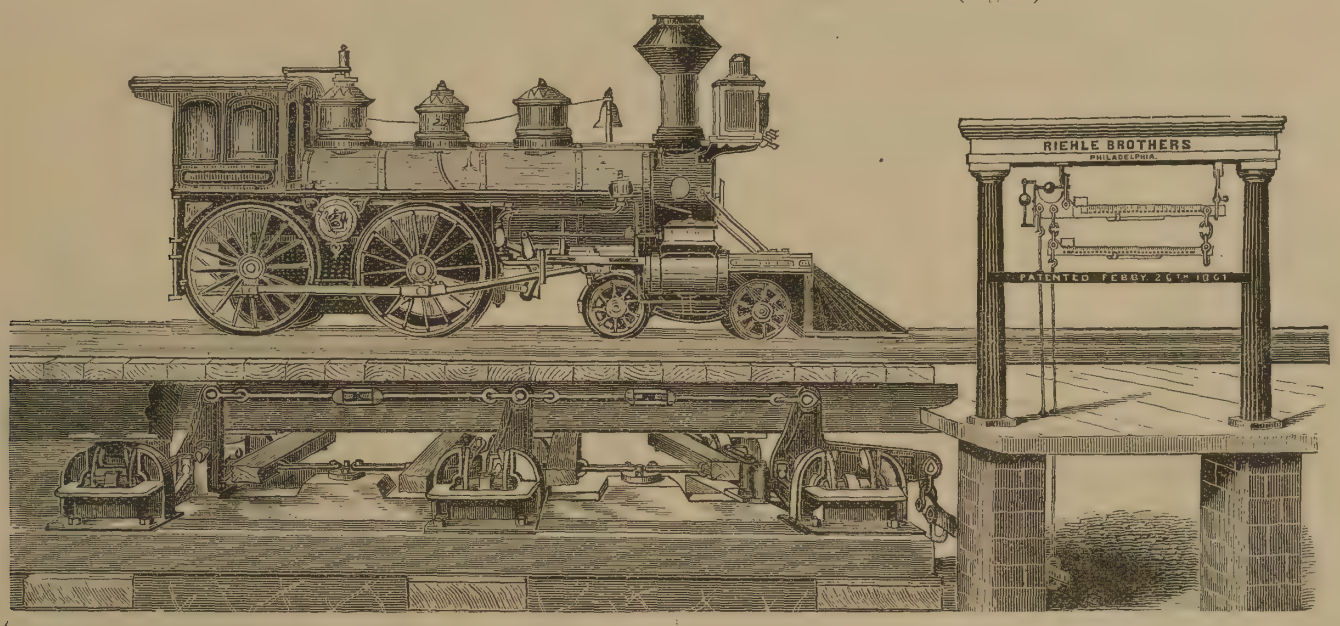
In the same way, those who do not wish to be asked to subscribe, as they buy our journal at the news-stands, should see in this aggressive growth of the REVIEW, continued improvement therein, without increased price.

We ask each subscriber, buyer, or advertiser, to make of our paper *a mutual benefit agency*, by recommending his friends and acquaintances to subscribe.

With an issue of ten thousand, we can give a much better paper for eight cents than with half that number; and with twenty or thirty thousand copies sent weekly throughout the whole country, and abroad, we hope to present a paper with which no fault can be found.

We are now sending out *the best paper that we can afford*, and ask all our readers to aid us to publish, at a very early date, *as good a paper as we know how to conduct.*

(Fig. 1.)



RIEHLÉ BROS.' SELF-ADJUSTING TRACK SCALES.

The accompanying illustrations show three sections of Riehle Bros.' new "selt-adjusting" railroad track scale, which is one of the most notable scales of their display in Machinery Hall.

Its construction seems to have been especially planned so as to combine strength with accuracy of record; and the patented improvements introduced on this scale have already obtained for it a well-deserved reputation for accuracy and durability.

The levers are short and slightly arched from centre to side of scale, and swing with a free but strongly-checked motion, with no danger of binding.

The chairs are low, with a wide base; very strong and heavy, and directly sustain the great burden of the load immediately beneath the wheels, having no long and heavy centre levers. The light ends of the levers are connected with the necessary bell-crank levers, and the whole is joined together with a connecting centre rod, which, after several years of discussion, is now generally allowed to be a valuable improvement. Self-adjusting blocks fastened to top chairs, which support the bearers and platform of scale, secure a solid bearing, even though the timbers might spring or twist slightly. The whole scale, from one end to the other, has its knife edges resting upon "rocking bearings," thus maintaining a perfect level, and producing the freest action possible; a slight settling of foundation need not crumble off the knife edges, which must be the case where the bearings are stiff and ungiving. The whole scale floats, as it were, and finds its own level. (Fig. 2.)

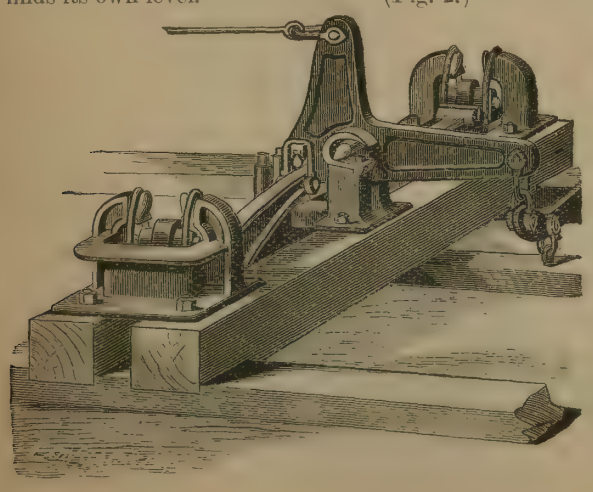
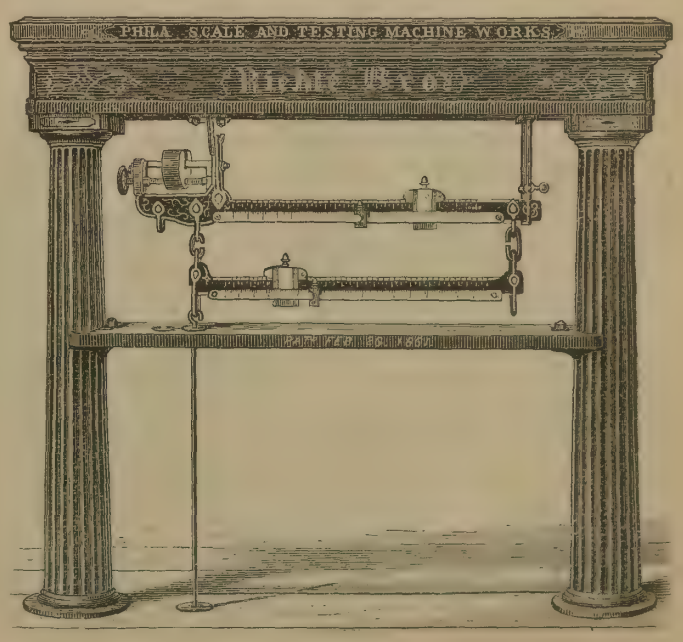


Fig. 2 shows an end section of the scale, from which the reader can obtain an idea of the relative position of top and bottom chairs, main levers with rocking blocks, etc. The fulcrums are longer than usual, but not too long, as the machine weighs with accuracy anything over the whole surface of the platform, however large; consequently the unusual length of bearings enable the scale to retain its sensitiveness a number of years without the bearings crumbling or becoming blunt in the least; and yet, as said before, the scale records with equal accuracy any small weight that scales of other makes will do, without getting dull in a much longer time. The parts being all interchangeable, in the event of accidents, etc., repairs can be readily done. Another important feature in this scale: it can be made of any length merely by lengthening the centre connecting rod and adding more sections; the maers' rule being ten tons to a section of ten feet. As the above illustration does not show the improvements recently introduced on the Messrs. Riehlé's beam, we give below another cut showing their beam and office fixtures. The double beam is connected with a link, with the intention of making both beams precisely alike, so that an equal amount of weight can be put on either; this enables the weigher to weigh cars in motion, as is done at Cressona and other places, where the scales are 100 feet long and over.

(Fig. 3.)



The advantage claimed for this double beam is that the length of beam admits more notches without crowding than an ordinary single beam, and also that the

two beams are entirely independent, and others may be added without in the least impairing the accuracy of either or all of them. One beam is used to balance the car; the weights being known, the other beam weighs the contents, thereby saving the trouble of weighing the whole amount, and deducting the known weight of the car. The side beam allows the weighmaster to move the poise as much as 2000 lbs. without being obliged to re-use the poise on the main beam. This beam is graduated to ten lb. marks.

The main poises, which are of brass, have a high wheel placed back of the centre, and a smaller one in the rear. The steel knife edge of the poise is held firmly in the notches by gravity instead of by a spring, as formerly used. To move the poise it is merely necessary to depress the rear end, throwing it upon the two wheels, which raises the knife-edge out of the notch, allowing it to run with great ease. The reader will notice a very important feature in the above cut, that of a "balance ball" that cannot work itself around during the process of weighing, which is often the case. It is propelled back or forth by the action of the screw turned by the hand at the butt end of the beam.

FIRE EXTINGUISHERS.

II.

In a recent number we considered the subject of Fire Extinguishing in general; citing among the various agents employed in the subduing of flame, sand, earth, water, steam, nitrogen, ammonia, sulphurous acid, and carbonic acid.

Perhaps the earliest carbonic acid extinguisher known is the common conical candle extinguisher, which, being placed over a candle so as to exclude the air from the flame, extinguishes the latter by the two-fold action of deprivation of oxygen and suffocation by the carbonic acid of its own combustion. There are now perhaps sixty patents on carbonic acid fire extinguishers. About the first introduced into this country was the Phillips Fire Annihilator, which P. T. Barnum brought into notice some twenty years ago,—and lost money on.

In this apparatus a compound of sugar and potassic chlorate was so placed as to receive the contents of a bottle of sulphuric acid, which was broken by striking a plug on the top of the can. Around the perforated case containing the chemicals was another case; and this was in a third envelope, between which last and the *outer* shell was a water-space.

But about the first extinguisher which achieved wide popularity and extended sale and use, was the Babcock, which we here illustrate in its varied applications, from the portable or hand size to the useful combination with a hook and ladder truck, etc.

The "Babcock" portable extinguisher (shown partly in section in Fig. 1) has an iron or copper cylinder with brass screw-cap on upper head. To this cap are attached two galvanized iron frame-posts, between which a shallow cup (B), with perforated bottom, is pivoted at its base, so as naturally to hang inverted. The cup (B) being righted, a fragile glass bottle (A) with a transverse corrugation, and sealed by a rubber cork, is placed therein, and held lightly in place by a spring and cap (C). The cylinder being filled with a solution of soda bicarbonate, and the bottle with strong sulphuric acid, the cap is screwed home. To generate the carbonic-acid gas, a stem passing through the cap is screwed down hard against the top of the bottle (A), jamming it between the cap (C) and the cup (B), and thus crushing the bottle. The cup (B), in turning over, pours out any acid that might remain in the bottom fragment of the bottle. A vertical copper pipe with a fine strainer at the bottom, to keep out fragments of glass, passes from the bottom of the cylinder to the hose pipe at top. The stop-cock is in the hose-nozzle. This apparatus may be rapidly and easily charged without injury to hands, clothing, or surroundings. The only faucet is beyond the reach of corrosion. It cannot be "set off" by upsetting or other accident. The acid is discharged at the top of the Extinguisher, while the opening of the outlet pipe is at the bottom, so that no acid can reach it without passing through all the water in the machine, thus insuring complete neutralization, so that she fluid is absolutely harmless.

Fig. 2 shows a "village and warehouse" engine, mounted on three wheels, and provided with tank of 60 or 80 gallons capacity. It carries 200 feet of hose, and the necessary pipes, nozzles and tools.

Fig. 3 shows the self-acting engine, built in four sizes, with capacities of 70, 100, 150, or 200 gallons.

Fig. 4 shows the apparatus as a stationary protector; one tank acting while the other is being charged.

The extinguishers form a very efficient adjunct to the ordinary hook and ladder truck; and we give herewith cuts showing two styles.

Fig. 5 shows a light truck, with the following equipment:

6 extinguishers, and 18 sets chemical charges; 1 ladder, 23 feet, with opening braces; 1 ladder, 19 feet, making with the last a 38-feet ladder; 1 ladder of 17 feet, and one of 14 feet, combining to form one of 28 feet; 1 ladder, 24 feet; 1 scaling ladder; 12 fire buckets; 2 pike axes; 2 axes; 4 pike poles; 1 hook and chain, with pole and rope; 4 lanterns; 1 signal lamp; 70 feet drag rope on reel. G.

(To be continued.)

Fig. 1.

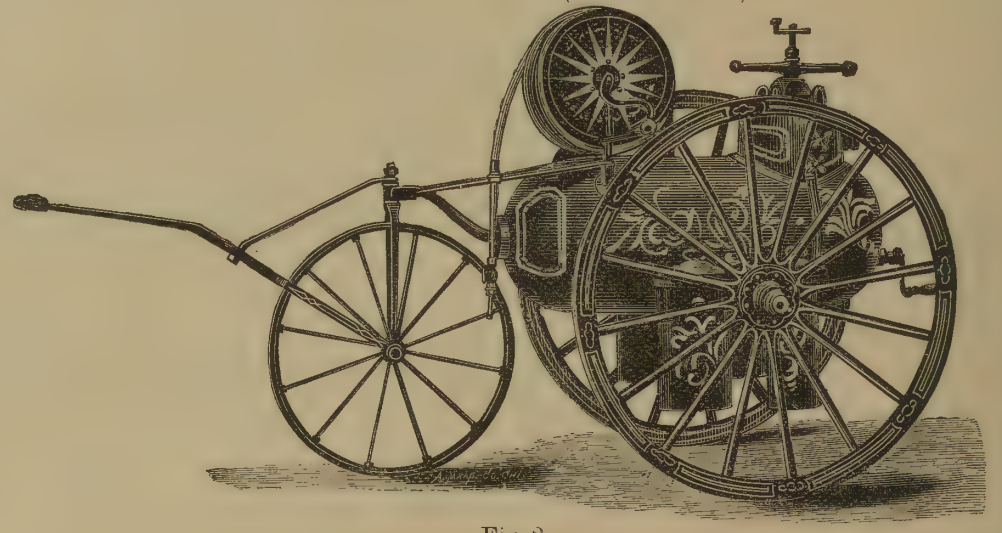


Fig. 2.

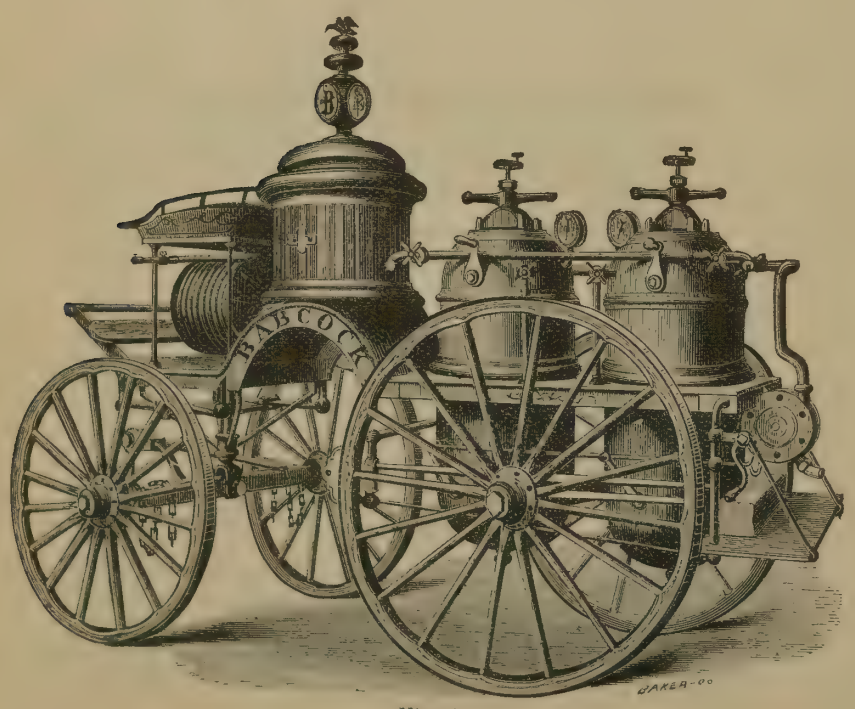


Fig. 3.

Fig. 4.

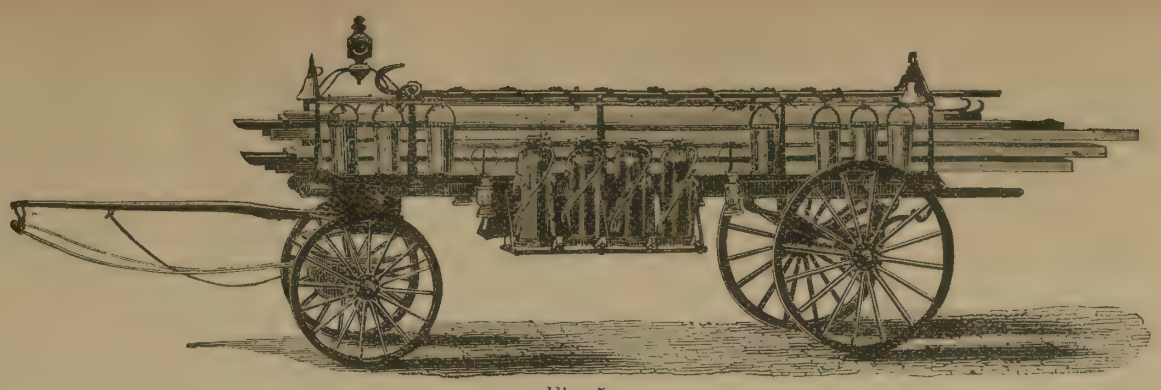


Fig. 5.

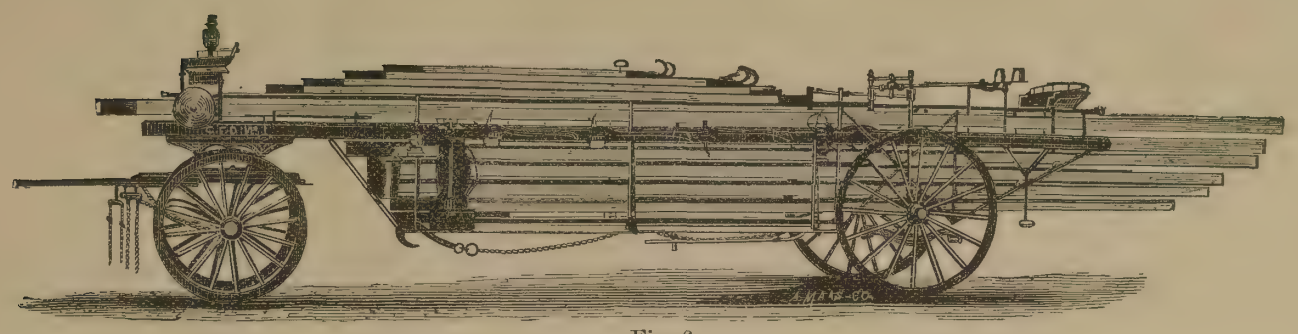


Fig. 6.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The Canton Elevator.—The Baltimore *Gazette* thus describes the new elevator now being built at Canton, near Baltimore: "The pier upon which the elevator is being erected is 500 feet long, and extends into the water to the port warden's line. It was built for the company by Sanford & Co., of New York, and is one of the most substantial works of its character in the harbor. The elevator, which is now almost completely under shelter, is 145×84 feet, and will have a capacity for storing 750,000 bushels of grain. There are 140 bins, varying in size from 8×9 feet upward, and each has an average depth of 62 feet, and being built of heavy timbers. There are two rows of shutes facing the water upon each side, the upper row carrying the grain direct from the supply pipe after weighing, and the lower from the stowage bins. These are to supply vessels with the grain. Under the elevator are four tracks, upon which the loaded cars are run, and are so arranged as to have a hopper for receiving the grain placed in such a position as that the contents of two cars can be received simultaneously, the unloading to be done with steam shovels. After being placed in the hoppers the grain is carried to the top of the elevator, first to the blowing department, where, if necessary, it is cleaned; thence to the scales, where it is weighed, and then either shipped direct to vessels, *via* the shutes, or into the stowage bin. There is also a traverse belt carrying the grain the full length of the building, which obviates material labor in transporting grain from one bin to another. As some of the shippers require their grain bagged, two capacious bagging rooms will be fitted up in each wing of the building. The whole exterior of the building will be covered with slate, and it is anticipated will be ready for occupancy about the first of October. Two large horizontal locomotive engines for the movement of the elevator machinery are being placed in the boiler room, which is situated in under the pier immediately in the rear of the left wing of the elevator and well encased in a house of solid brick and stone masonry, the dimensions of which are 64×19 feet. In the rear of the elevator have been erected two covered sheds, 110×25 feet, for the reception and handling of freight in transit. An additional pier and lock has also been built adjoining the elevator, at which the barge recently manufactured by the company will land with freight from the city station, thus avoiding the usual street truckage, which expense has hitherto amounted to no inconsiderable sum of money."

India-Rubber Collectors have confirmed the report of Mr. Gogorza in regard to the low pass across the Isthmus of Darien. They report a gap through which canoes are dragged from the Cacarica river into the Paya, one of the tributaries of the Tuira river. These reports are also confirmed by a resident miner and by the Indians of the region. Surveys are to be commenced by Nov. 28th, and a report made to the Colombian government within six months thereafter, when we shall know more definitely in regard to the feasibility of the route. All the news thus far is certainly encouraging, but we fear that Mr. Gogorza is doomed to disappointment on that route. [*Eng. News*, iii, 258.]

A New Fountain Nozzle of very ingenious and novel construction has been devised by M. Turettini, of Lyons, France, which promises to be of great value to cities which have water supplies of considerable head. It has been tried in Lyons and also Geneva, Switzerland, and has met with complete success. It is on the principle of the Giffard injector, the narrow nozzle through which the water issues with great velocity, being surrounded by a "petticoat" which bulges just above the interior nozzle and is then drawn out into a larger nozzle; the lower part of the "petticoat" dipping beneath the surface of the water in the basin. The water is drawn from the basin and carried up with the stream from the interior nozzle, thus augumenting the volume discharged, but of course to a less hight. As small jets under great heads break up at no great hight, this diminution in hight of jet is less than would at first be supposed. An additional petticoat may be provided connected with the air by a pipe, the air drawn in converting the jet into a mass of spray. The economy of this jet is said to be 40 to 50 per cent., but of course this will vary much with head, the result to be attained, etc. [*Eng. News*, iii, 250.]

Cable Towing on the Erie Canal.—The Lockport (N. Y.) *Times* recalls the fact that two years ago a company laid in the canal, between that place and Buffalo, a small wire cable, which, attached to a peculiarly constructed power, upon a tugboat built for that purpose, was used as a means of towing boats. Last season, owing to embarassments which seem inseparable from new undertakings, little or no success attended the enterprise. This season, however, the results have been more satisfactory. A portion of the cable was taken up and relaid towards the east, and it has been in operation from the Guard Lock west to Middleport east, a distance of about twenty miles, for the past two months. The results have been so satisfactory as to induce its projectors and many others, to believe that they have solved the problem of cheap and rapid canal transportation. The depressed state of canal business, and the fact that nearly all boats carry their own teams, has operated against its power, but notwithstanding its greater speed has caused many boatmen to avail themselves of its use, especially in the narrow channel and rapid current above the locks, where horse-propelled boats have a difficulty in making only two miles an hour. The cable boat will take a tow of five or six boats and propel them easily against this current at the rate of four or five miles an hour. It does this without creating an unusual swell in the canal, and with an astonishingly small consumption of coal. We have not the data from which to state accurately the amount of its towing powers or its costs.

—The work of dredging the Cove basin in Providence, R. I., will be begun about the first of September. The contractor, Mr. John B. Wood of Brooklyn, N. Y., is going to build two scows, 50 feet long and 13½ feet wide, upon the Cove lands, just above the Gaspee street bridge, and will launch them in the Woonasquatucket River. These will be floated through the bridge into the Cove, and joined together with a foot's space between them. Upon these scows will be placed the dredging machine, which is of peculiar construction, being invented and patented by Mr. Wood. Three other scows will be then built, 65 feet long, 16 feet wide and 4 feet deep each; on these a railroad track will be placed, and on the track five six-yard dumping cars will be run. The wall of the Cove, at a point about 150 feet from the above named bridge, will be taken down for a distance of forty or fifty feet. Here an inclined plane, or more exactly a floating wharf, which will rise and fall with the tide, will be constructed. The railroad track will be continued from the scows over this wharf and thence to the Cove lands or anywhere else that is decided upon. By means of this apparatus the 270,000 cubic yards of mud will be taken out. The Cove will be dredged for a depth of three feet below low-water mark, and as the mud is many feet above that mark in some places, the average dredging will be five feet. [*Eng. News*, iii, 262.]

—A contract between Mr. Gogorza and the Colombian government has been made for the survey, and, if practicable, the building, of the Darien Interoceanic Canal. The surveyors are to be on hand within six months after May 28th. They are to be of several nationalities. The result of the surveys is to be submitted to the Colombian government within six months after the commencement of the surveys.

—An English paper says: "The introduction of large ships of war has rendered the old-fashioned hawsers comparatively useless. For this reason some new experiments have been made with steel hawsers at Devonport under the authority of the British government. The steel hawser used was eight inches in circumference against a hemp one that was twenty-five in circumference. The report as to handiness in working was entirely in favor of the steel wire hawser. Another great consideration is that 120 fathoms of 24-inch hemp cable weighs seven tons sixteen cwt., while the same number of fathoms of eight-inch wire cable, which is equal to, if it does not exceed, the strength of the other, weighs only two and one-half tons. The wire rope which was tested is equal in strength to a two and one-half inch chain, the weight of which would be sixteen tons."

CENTENNIAL NOTES.

The Reading Bolt and Nut Works (J. H. Sternbergh, proprietor) has on exhibition (Machinery Hall, A, 41) a full line of nuts, bolts, washers, lag screws (or wood screws), skein and track bolts, set and tap screws, turnbuckles and bolt ends. The nuts are noticeable for the quality of iron, and the accuracy, uniformity and smoothness of hole, etc., owing to the method by which they are made. They are hot-pressed, in distinction from cold-punched. It is claimed that the former are superior because the hole punched is round, smooth and almost as true as if drilled, and admits of cutting a perfectly solid and full thread; whereas nuts punched cold, unless they are subsequently re-punched or drilled, have a ragged hole, the fibres of the iron being more or less disintegrated and broken in the process of punching, especially after the piercing punch has penetrated one-third or one-half the way through. In cutting the thread in cold-punched nuts, the tap frequently loosens these broken fibres, and they crumble out with the tap; and the thread is found broken and imperfect, especially in the center of the nut.

Another distinction between hot and cold punched nuts is that the latter are apt to have holes a little greater in diameter one way than the other, caused by the spreading of the unsupported sides of the bar as the punch passes through it. This objection does not exist in the hot-punched nuts here exhibited, owing to the manner in which they are made, each nut blank being severed from the end of a heated bar of iron, forced into a square, or hexagonal die box, pressed into a true, and uniform, and mechanical shape; while under such pressure the core is punched out of the nut, the sides of the latter meanwhile being supported by the sides of the die box, thus obviating all possibility of the nut being split open or cracked in the least, in the process of punching. By this method of punching, the fibres of the iron around the hole in the nut are left undisturbed and the thread when cut is found to be perfect and of the utmost strength that the iron will admit. This is important for the reason that a prime requisite in a nut is the perfection and strength of its thread.

Another distinction noticeable between hot punched and cold punched nuts, is that the former have their holes punched more nearly at right angles to the top and bottom of the nut; a result not often found in cold punched nuts, which (owing to the method in which they are made) are almost without exception convex on the under side and concave on the upper side. This mechanical shape of a nut is important, for the reason that when threaded and screwed down upon its bolt, the bottom of the nut should turn true with the bearing upon which it rests: otherwise it is liable to twist the bolt first one way then another, and strain or crack the bolt in the thread under the nut, just where it would be least observed, and where the rod would first break. For this reason almost all engineers and bridge builders prefer a well made hot punched nut to one cold punched. The nuts here exhibited are made at one operation at the rate of thirty or forty a minute on machinery of Mr. Sternbergh's invention and construction, and while it is claimed that they are a preferable article, they can at the same time be made so rapidly as to be afforded at a low price.

An element of merit in the bolts, wood screws, turnbuckles, etc., here exhibited, is in the quality of iron used, samples bent cold being shown on the case, as well as the general features of uniformity, proportion, finish, etc. They are stated be fair specimens of such goods as the maker is shipping to his customers every day; not being made for the purpose of exhibition, but taken from stock on hand, and not even being the finest specimens that could be made with new tools.

In Annex No. 2 to Machinery Hall, Mr. Sternbergh has on exhibition a patented "Surface Grinding Machine" of his invention, adapted to grind with rapidity and accuracy any hard metal surface, such as chilled iron, hard steel or other metal, which cannot be planed with the ordinary planer. It consists essentially of an ordinary iron planer, having an emery or corundum wheel mounted in the place of the steel cutting tool. This wheel is driven by two belts, one on each side, at high speed, and is fed across the table carrying the work, or raised or lowered to suit the work, in the same manner as the sliding head of an iron planer. An exhaust fan carries away the dust from the work.

This machine is adapted to a variety of work for which the iron planer is not fitted; and the maker has had it in use in his own establishment for several years, as he states, with great advantage and profit.

CAMBRIA IRON WORKS.—DESCRIPTION OF EXHIBIT.

Metals and Manufactures in Main Building, T, 65. A pyramid, constructed of sixty different sections of iron and steel rails; iron and steel representing the various stages of manufacture; bars and rails showing tests by tortions, compressions, tensile strains, and abrasions in actual service; with record of chemical and mechanical tests and analyses; also, photographic views of machinery, buildings, and materials; statistics of production; and diagrams of sections, with record of distribution of rails to consumers.

Minerals and Materials in Main Building (Annex), W, 66. An arch, exhibiting pig-metal from which the iron and steel rails of the Company are made, and exhibiting, also, the ores, fuels, and fluxes used in the manufacture of the same; viz., carbonates of iron, hematite, levant, and other fossil ores used in making metal for iron rails; and limonite, manganiferous, specular, and magnetic ores used in making metal for steel rails. Also limestones, calcitic and dolomite; fuels, viz., cokes and semi-bituminous coals; refractory materials, viz., fire-clay and ganister, Also photograpic views of mines and mining machinery; methods of preparing ores and fuels; plans of workings; geological sections; statistics of area, production, etc.

Place of Production. Rails and iron and steel in various forms, at Johnstown, Pa.; spiegeleisen, at Frankstown, Pa,; pig-iron, at Johnstown, Bennington, Pa., and Hollidaysburg, Pa.; fossil ores at Frankstown; fossil and levant ores near Marklesburg, Pa.; soft and hard fossil ores at Hopewell, Pa.; carbonates of iron at Johnstown; hematite ores at Huntingdon County, Pa.; limonites, at Springfield, Pa.; manganiferous ores at Henrietta; limestone, at Blair County, Pa.; coal and coke at Johnstown, Bennington, and Broad Top, Pa.; fire-clay at Johnstown and Springfield, and ganister at Blair County—all being from the mines and works of Cambria Iron Company, which also uses, as mixtures, specular and magnetic ores from Republic, and other mines, Michigan, and manganiferous ores imported from Spain.

Record of the actual service in track performed by Cambria Iron Rails, exhibited as above:

No. 1 was eleven years in north main track of Pennsylvania Railroad, near Florence, Pa., on a down grade. During that time, 34,432,060 tons passed over it. Its original weight was 67 lbs. per lineal yard, and it lost in weight by wear in that service 3 713-1000 per cent.

No. 2 was eleven years in south main track of Pennsylvania Railroad, near New Florance, Pa., on an up grade. During that time 46,117,721 tons passed over it. Its original weight was 64 lbs. per lineal yard, and it lost in weight by wear in that service 5 218-1000 per cent.

No. 2 was eleven years in north main track of Pennsylvania Railroad, near New Florence, Pa., on down grade. During that time 34,422,060 tons passed over it. Its original weight was 67 lbs. per lineal yard, and it lost in weight by wear in that service 6 052-1000 per cent.

No. 4 was ten years in the north main track of Pennsylvania Railroad, near 170th Mile Post, on an up grade. During that time 40,827,000 tons passed over it. Its original weight was 67 lbs. per lineal yard, and it lost in weight by wear in that service 2 352-1000 per cent.

No. 5 was ten years in north track of Pennsylvania Railroad near 170th Mile Post, on an up grade. During that time 40,827,000 tons passed over it. Its original weight was 67 lbs. per lineal yard, and it lost in weight by wear in that service 2 352-1000 per cent.

No. 6 was nineteen years in main track of Dayton & Michigan Railroad. (Have not been able to obtain record of tonnage service performed.) Its original weight was 56 lbs. per lineal yard, and it lost in weight by wear in that service 4 762-1000 per cent.

No. 9 was ten years in the north main track of Pennsylvania Railroad, near 170th Mile Post, on an up grade. During that time 40,827,000 tons passed over it. Its original weight was 67 lbs. per lineal yard, and it lost in weight by wear in that service 2 352-1000 per cent.

No. 10 was 10 years in north main track of Pennsylvania Railroad, near 170th Mile Post, on an up grade. During that time 40,827,000 tons passed over it. Its original weight was 67 lbs. per lineal yard, and it lost in weight by wear in that service 2 352-1000 per cent.

No. 11 was ten years in north main track of Pennsylvania Railroad, near 170th Mile Post, on an up grade. During that time 40,827,000 tons passed over it. Its original weight was 67 lbs per lineal yard, and it lost in weight by that service 2 352-1000 per cent.

Two iron rails which bridged a gap 12 feet wide and 12 feet deep, washed out under the track of the G. R. & Ft. W. R. R., and carried safely an engine weighing 57,400 lbs., a train of seven cars.

History and Statistics. The Cambria Iron Company was organized under the General Iron-Manufacturing Law of the State of Pennsylvania of 1836; its charter is dated August 21, 1852, and it has received numerous additional powers and privileges by special acts of the Legislature. The early operations of the Company were unsuccessful, and its works were leased to Wood, Morrell & Co., in 1855, at which time Daniel J. Morrell removed from Philadelphia to Johnstown, and became General Superintendent. Wood, Morrell & Co. built up a large and profitable business, and made important improvements in the works, and, at the termination of the lease, in 1862, the Company was reorganized, and the business has since been caroied on in its name. Charles S. Wood was elected President, E. Y. Townsend, Vice President, and John T. Killé, Secretary; D. J. Morrell continuing in the management at Johnstown. Upon the death of Charles S. Wood, in 1872, the organization was constituted as it is at present, viz: E. Y. Townsend, President; Charles S. Wurts, Vice President; J. T. Killé, Secretary and Treasurer, and D. J. Morrell, General Manager at Johnstown. Of the original Directors elected at the reorganization of the Company, Richard Wood and Charles S. Wood are dead, and George L. Oliver, John M. Kennedy, George Trotter, E. Y. Townsend, and D. J. Morrell are still in the management, having Samuel Welsh, Samuel J. Reeves, Charles S. Wurts, and Henry Lewis associated with them as Directors.

The mills of the Company and four of its furnaces are at Johnstown, Pennsylvania, on the line of the Pennsylvania Railroad, 72 miles east of Pittsburgh. The ore of this locality produces a quality of iron which is specially adapted for service in a railroad bar; and this, in connection with large deposits of coal, fire-clay, and cement, gives to Johnstown peculiar advantages for the manufacture of iron and steel rails. The town and adjoining buroughs contain about 16,000 inhabitants, of various nationalities, the largest number of foreign birth being Irish, Welsh, and German. There are about five thousand workmen and employés in the various departments of the Company's business. Males only are employed in the mines and iron and steel mills, but the woolen mills of the Johnstown Manufacturing Company, operated by Wood, Morrell & Co., at Woodvale, give work to a large number of women and girls. The place is noted for healthfulness, and the good order, thrift, and contentment of the people.

The Centennial exhibition of the Company, heretofore described, shows, fully and fairly, average specimens of its various materials and manufactured products, and the extent of the possessions of the Company is indicated by the places of their production. Manufacturing operations are conducted in the counties of Cambria and Blair, and mining in Cambria, Blair, Bedford, and Huntingdon. The Company has four blast furnaces in operation at Johnstown, and one at Conemaugh. The four furnaces east of the mountain, one at Bennington, two at Hollidaysburg, and one at Frankstown, operated in tha name of Blair Iron and Coal Company, are under the General Manager of the Cambria Iron Company. The Company is erecting, and will soon put in blast, a new furnace at Johnstown, having all the modern improvements, and of the estimated capacity of 100 tons of metal per day. The manufacture of Spiegeleisen, largely from native ores, which was successfully inaugurated at Frankstown, will be carried on at Conemaugh Furnace, which has been thoroughly refitted for this purpose. The Bessemer steel works, blooming mill, rolling mills, machine shops, foundry, and other shops and buildings at Johnstown, extend over sixty acres of land, the rolling mills covering seven acres. The rolling mill contains seven trains of rolls, twenty-eight heating furnaces, and forty-two double puddling furnaces. It was burned in 1857, and again in 1872, and in each instance was at once rebuilt. Such were the resources of the Company, the energy of the management, and the co-operation of the employés of the Company, that within one week after the last fire all the machinery of the mill was in full operation, under temporary shelter, which was replaced by permanent buildings without stopping a wheel or injuring a workman. The water works now completed will be a defense against like calamities in future.

The Bessemer plant contains two five-ton converters, arranged on the most improved American plan, with a capacity and effectiveness not known in Europe. Numerous improvements upon the machinery and process have been made at Cambria Works, chief of which is the blooming mill for the reduction of steel ingots, invented by George Fritz, formerly Chief Engineer of the Company, who is now deceased.

The Company has about twenty miles of railroad, of ordinary gauge, in, about, and connecting its works, and as many miles of narrow-gauge track in its mines, and thirteen locomotives are kept in constant service.

The lands of the Company in the counties of Cambria, Indiana, Westmoreland, Somerset, Bedford, Blair, and Huntingdon, aggregate forty-six thousand four hundred and three acres, forty-one thousand of which contain minerals.

The estimate of the mineral resources of the Company, in tons, made by John Fulton, Esq., Mining Engineer, is as follows: Coal, 350,000,000; iron ores—carbonates, 17,000,000; red hematite, fossil, 1,927,000; brown hematite, limonite, 5,176,000; fire-clay, 75,000,000. The Company also owns large deposits of superior ganister.

The stock of Cambria Iron Company, amounting now to $3,000,000, was originally divided in shares of $12.50 each, and, under a resolution of the stockholders, will be raised to the par value of $50, by consolidation of four shares of the original stock into one share of new stock. There is no bonded debt, and no floating debt beyond what is settled and paid at the end of each month, in the usual course of business.

Beginning with a product of 10,000 tons of rails in 1855, the Company has made, year by year, one-tenth of the total product of American rails, its contribution up to this time being more than a million of tons, and the works now have the capacity to produce a hundred thousand tons of iron and steel rails per annum.

Cambria steel rails were first made in 1871, and were sold in 1873 at $125 per ton, which was then about the ruling price of English steel rails. The difference between that and the present price of steel rails is an evidence of the skill and economy developed in the management of this new industry, and illustrates the advantages to consumers which always result from protection to home labor.

Mindful of the importance of extending the uses of Bessemer steel, the Company is preparing to place a portion of its product upon the market in the form of wire, screws, and other articles for which Bessemer steel is better suited than iron. While doing this the Company proposes to maintain and improve the character of its rails, to meet the market in its prices, and to retain its customers, and confidently refers to the railroad companies of the United States for evidence of the superior quality of its rails."

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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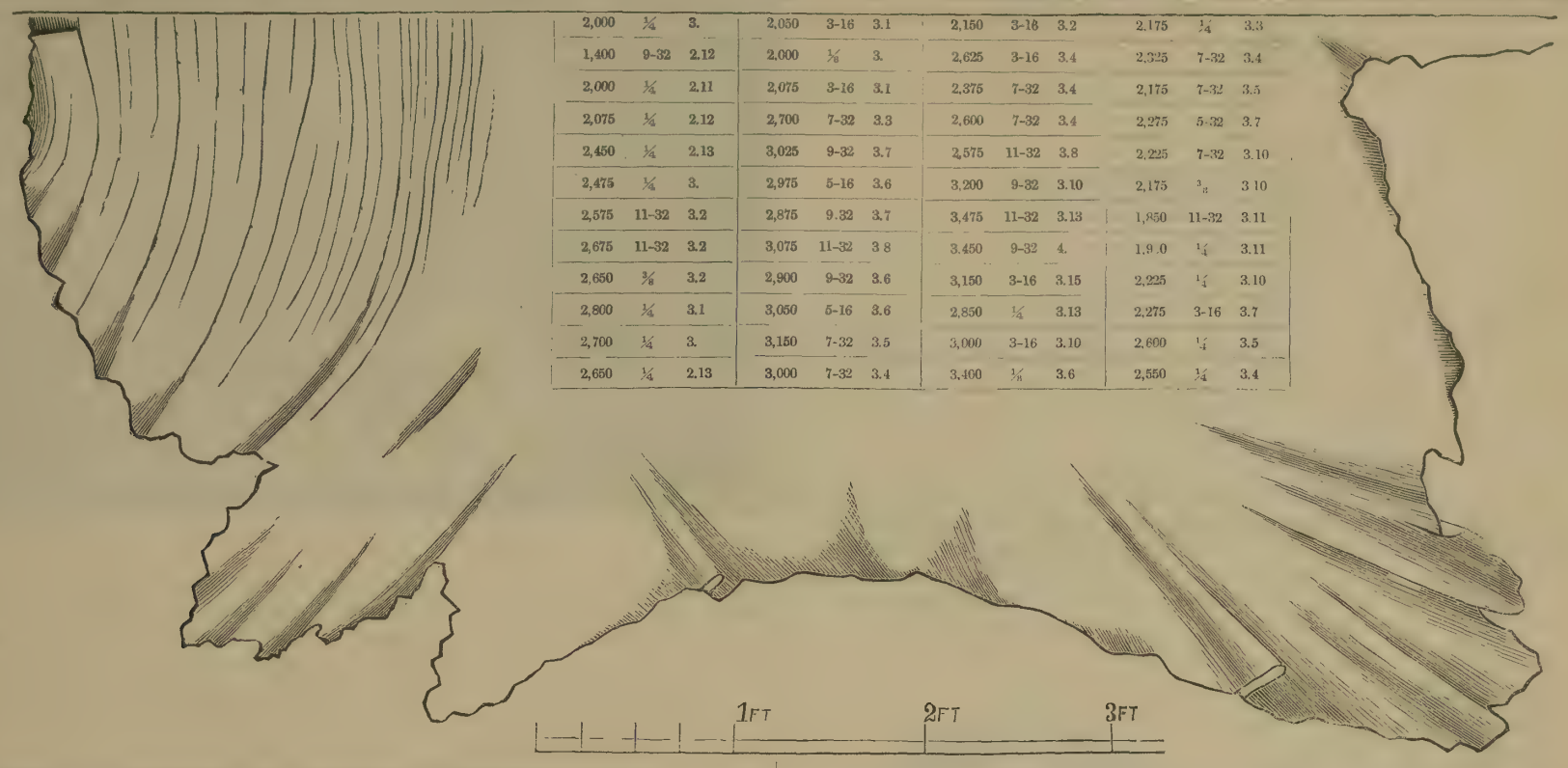


2,000	¼	3.	2,050	3-16	3.1	2,150	3-16	3.2	2,175	¼	3.3
1,400	9-32	2.12	2,000	⅛	3.	2,625	3-16	3.4	2,325	7-32	3.4
2,000	¼	2.11	2,075	3-16	3.1	2,375	7-32	3.4	2,175	7-32	3.5
2,075	¼	2.12	2,700	7-32	3.3	2,600	7-32	3.4	2,275	5-32	3.7
2,450	¼	2.13	3,025	9-32	3.7	2,575	11-32	3.8	2,225	7-32	3.10
2,475	¼	3.	2,975	5-16	3.6	3,200	9-32	3.10	2,175	⅜	3.10
2,575	11-32	3.2	2,875	9-32	3.7	3,475	11-32	3.13	1,850	11-32	3.11
2,675	11-32	3.2	3,075	11-32	3.8	3,450	9-32	4.	1,900	¼	3.11
2,650	⅜	3.2	2,900	9-32	3.6	3,150	3-16	3.15	2,225	¼	3.10
2,800	¼	3.1	3,050	5-16	3.6	2,850	¼	3.13	2,275	3-16	3.7
2,700	¼	3.	3,150	7-32	3.5	3,000	3-16	3.10	2,600	¼	3.5
2,650	¼	2.13	3,000	7-32	3.4	3,400	⅛	3.6	2,550	¼	3.4

TESTS TO DETERMINE THE BREAKING STRAIN OF LEATHER.

The above illustration represents a side of leather, and is made to the scale of one inch to the foot; the marks show the size and shape of the specimens tested, and the figures give the strain in pounds at which each piece broke, the permanent elongation in fractions of an inch, and the weight in ounces and drachms. The pieces were each 11¾ inches long by 2 inches wide, and were taken out of the exact portion of the hide on which they are marked.

The tests were made by Messrs. Riehlé Brothers, at the Testing Department of their works, for Messrs. J. B. Hoyt & Co., of New York, for the obvious reasons of determining by actual experiment, the tensile strength of the different portions of a side of leather.

The tests have been the means of awakening new interest in important investigations, as to the comparative value of the various portions of sides of leather for special purposes, and as to the best means of producing the best results. Until comparatively lately the testing of iron and other metals, excepting by the crudest methods, was almost entirely neglected, but now testing has become a necessity, and the value of metals is determined between buyer and seller by their endurance under certain tests that are brought to bear upon them, and that correspond to the special use that they may be required for. This, no doubt, will be the method of determining the value of leather, especially that used for belting, &c., and the comparison of tests made with patented and rubber belting is interesting and useful.

HALL'S SELF-ACTING SHINGLE AND HEADING MACHINE.

In the cuts herewith presented, are given very clear representations of the Hall Shingle Machine, made by the Buckeye Engine Company, of Salem, Ohio, and exhibited (not in operation) at B, 70, Machinery Hall.

The functions of the machine are to hold a block of any given length; to present its side to the cutting action of the saw, and withdraw it therefrom; to make an adjustable transverse feed, regulating the thickness of the shingle; and to give the shingle the desired amount of taper, which shall be variable at will, but constant for each adjustment. All these functions must be automatic from the time of feeding the block until it is entirely sawed up.

Referring to the cuts, M (Fig. 1) is a plate, behind which (and seen in Fig. 2) is the upper feed roll, bearing toothed feed or spurred wheels. A similar feed-roll is seen near the bottom of the carriage, (Fig. 2) which is directly under and corresponding to M (Fig. 1.) The upper feed-roll at M being swung on levers, is slightly adjustable in the vertical plane, to accommodate itself to slight inequalities in the length of the spalls or blocks. The feed-rolls are seen to bear ratchet-wheels actuated by pawls and levers from behind, and producing the feed. The feed-rolls (answering to the dogs) and their burden, slide, with the upright, B, on a carriage in longitudinal ways, and are brought quickly back by the combined action of a spring and weight after being presented to the saw. Small hinged stops seen at the bottom of the machine, determine the amount of advance of the carriage, according to the width of the shingles. At the side of the machine will be seen the upright revolving set-shaft G, which is

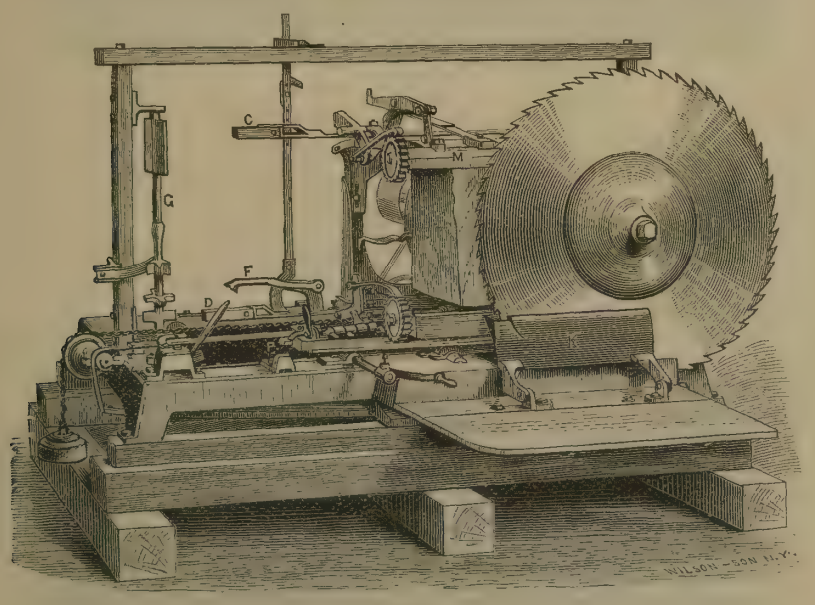


Fig. 1.

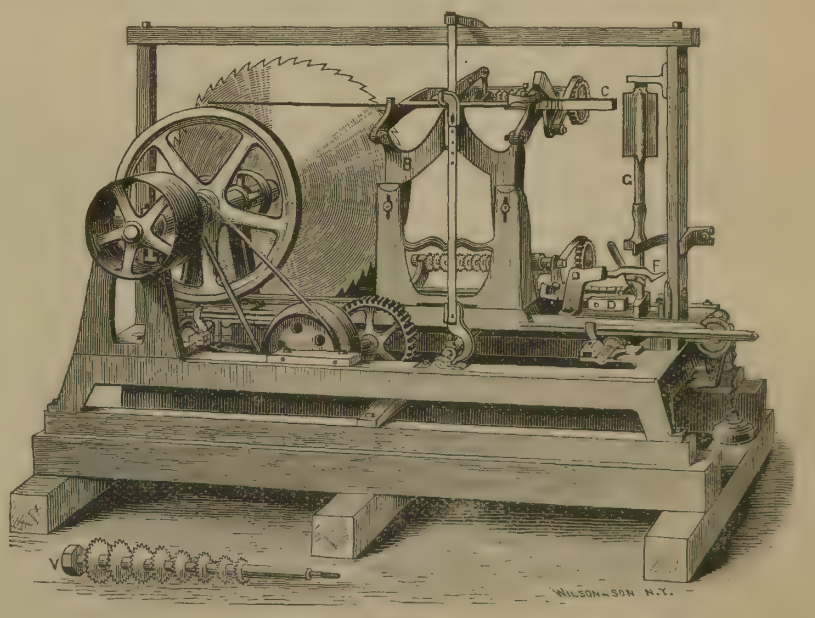


Fig. 2.

given one-quarter revolution at each advance of the carriage. Against unequal projections on this shaft the inclined planes, C, D, are pressed on the return of the carriage; and accordingly, as the projection is sooner or later met by these inclines, are the pawls made to engage one or three teeth of the ratchet wheels. The amount of projection of the blades is such as to produce a feed at top and bottom, which shall alternate "butt" and "point," of the shingle. Should a tapering block be presented in the dogs, the set-shaft may be so adjusted by hand as to cut two or more successive "butts" from the thick end of the block, and render the subsequent cuts more nearly vertical, or riftwise of the timber. An adjustable bar and hook at the back of the machine, allows of adjusting the feed-rolls to greater or less lengths of blocks. To insert a block in the machine, the top roll is raised by a lever actuated by a crank in the bottom.

The machine works blocks from 14 to 21 inches in length, and up to 14 inches wide, using a 38-inch saw and cuts, as the makers claim, 3000 shingles per hour from soft wood, with a consumption of 15 to 20 H. P.

The claims of the makers are that the changes to different thicknesses or lengths are made in a moment's time, and without changing the uniformity of taper or evenness of butts and points. G.

THE WARDWELL "VALVELESS" ENGINE.

(B—77, MACHINERY HALL.)

We find that one of the most important questions in engine construction is the proper porting of the steam cylinder, and the opening and closing of these ports in such manner as to give the steam free entrance, a sharp cut-off, and a free, open, and properly timed exhaust. Valve motion has become quite a problem, for which excellent solutions are found in the Buckeye, Bilgram, Corliss, and Putnam cut-offs, which may be mentioned as showing four types of the very best valve-gearing in engine practice. The greater or less complications of these styles are compensated for by the increased efficiency due to a variable cut-off.

Where the government of an engine is to be effected by throttling, and it is not required that the cut-off be adjustable, it becomes desirable to reduce the complication by causing the piston itself to perform the valve function. There are in Machinery Hall three exhibits of engines built upon this plan. Two of them—one in the British and one in the Russian department—are upon the patents of Robertson of Glasgow; the third is shown by Mr. Geo. J. Wardwell, of Rutland, Vermont (see Fig. 1). In

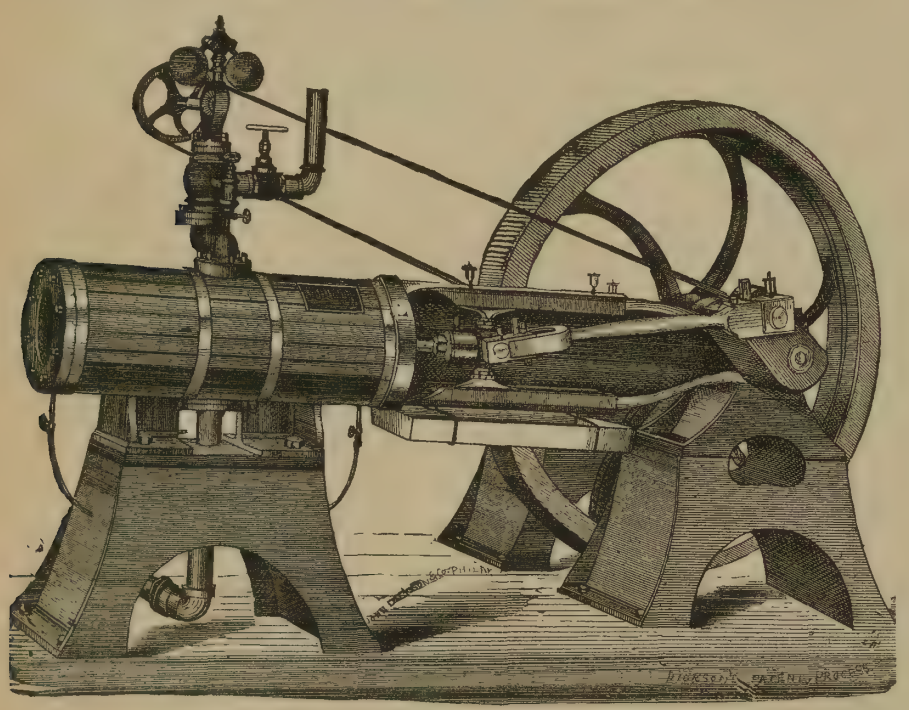


Fig. 1.—THE WARDWELL VALVELESS ENGINE.

all of them the steam passes directly through a port in the cylinder, to one or the other side of the piston, as determined by ported passages in the piston head; which latter is given a reciprocating semi-rotary movement.

We shall here describe in detail the American or Wardwell engine, showing its points of difference with the others exhibited.

It is horizontal, with one end of a girder frame bolted to and supporting the cylinder, and the other the pillow block. The cylinder has a bore 8×35 inches; the stroke is 16 inches. The pillow-block brasses have side adjustment by wedges, operated by bolts and nuts, from the top cap-face. The cross-head has V-shaped bearings, and has a gudgeon which provides journal-bearing for the fork end of the connecting rod. The piston-rod passes through the cross-head, in which it has journal-bearing for its semi-rotary motion; a nut and check nut preventing longitudinal motion or "end-play" in this bearing. The connecting-rod has a good feature; the strap at each end is secured to it by a bolt passing through the ties, the key serving merely to adjust the brasses. Inside the outer fork of the connecting-rod, is bolted a section of a bevel-wheel, with four teeth, and which gears into a similar but five-toothed section, keyed to the extreme end of the piston-rod. The reciprocation of the piston-rod produces an oscillation of the connecting-rod; but the two rods being geared together, the piston-rod and head are given the reciprocating semi-rotary motion desired.

The piston head is solid, having spring packing rings at each end, and a longitudinal spring-packing piece separating the steam passages. The steam port is in the center of the cylinder, at the top; its dimensions being $3\times\frac{3}{4}$ inches. The exhaust port is 3×1 inches, and diametrically opposite. The steam passages in the piston are seen in Fig. 2. They run along the circumferential surface of the piston head in a longitudinal but curved line,* which keeps the passage open to the cylinder port up to

* This line is an arc of an ellipse whose major axis is the stroke, and whose minor is determined by the angle of rotation given the piston by the bevel gearing.

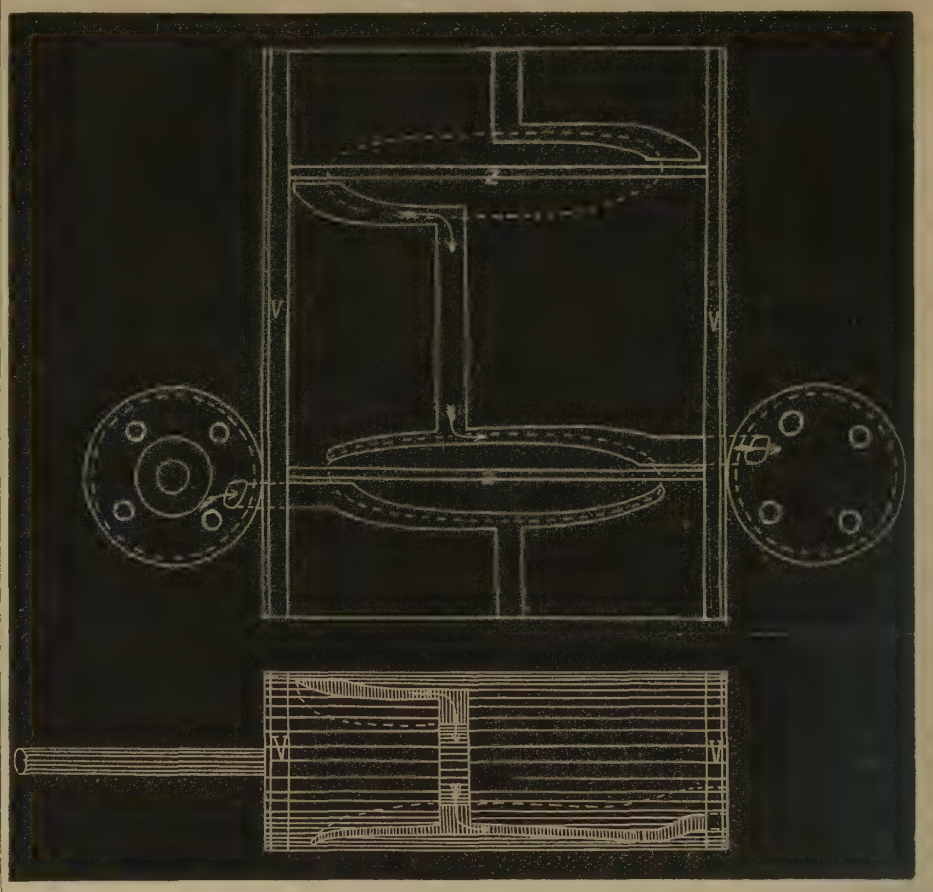


Fig. 2.

that part of the stroke and rotation when the cut-off is desired. Here the cut-off is effected by turning the passage sharply at right angles and in the direction of the piston rotation, giving the rest of the stroke under expansive steam. The steam-passage, after the abrupt turn mentioned, continues longitudinally to the end of the piston head; and at the end of the stroke is in communication with the exhaust port of the cylinder, and immediately acts as the exhaust passage, a similar or complimentary passage alternating with it for steam and exhaust successively.

In the Robertson engines (English and Russian) there are two steam and two exhaust passages in the piston head. They are spiral in their course, and so directed as to lie partly open at the centre of the convex piston-surface, while opening slightly within the circumferential line of the piston-end.

The passages shown are those in the vertical oscillating engine. In the horizontal engine the "cut-off" portion passes below the convex surface of the piston, thus diminishing side pressure. There being, in these last, two steam and two exhaust passages, there is at each end of the stroke an exhaust passage to be filled ineffectively with live steam.

Fig. 3 shows a diagram taken from the Wardwell engine. The steam line is perfect, the cut-off not sharp, the expansive curve unusually regular.

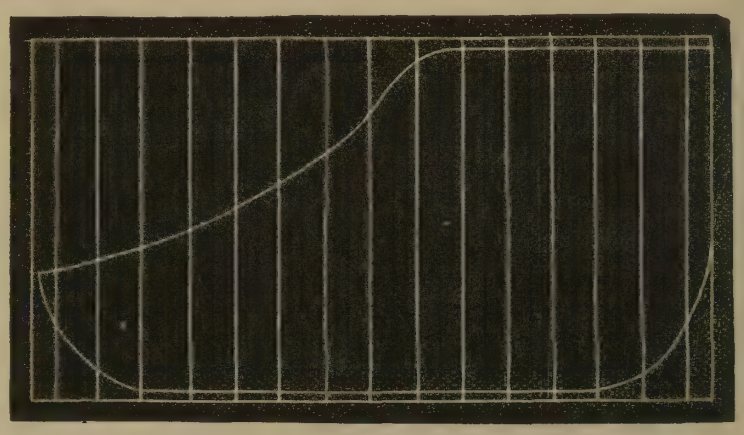


Fig. 3.

This diagram was taken while a friction brake was applied to the 5-foot fly wheel, and figures up as follows:

Mean effective pressure, 38 lbs.; H. P. value of 1 lb. M. E. P., ·405; I. H. P.= $38\times\cdot405=15\cdot39$.

The card shows that the exhaust opens quite late, but quickly; the fact that the exhaust port is not open until the end of the stroke is reached, explains the fact of the curve being all on the lower corner. The cut-off is remarkably quick and sharp for so late a point as half stroke. The compression, induction, and steam lines are very good. Assuming $6\frac{6}{10}$ per cent. of clearance, the actual terminal pressure is not more than $1\frac{1}{2}$lbs. above the theoretical terminal.

There is a want of lead at the exhaust end, which might be readily remedied in

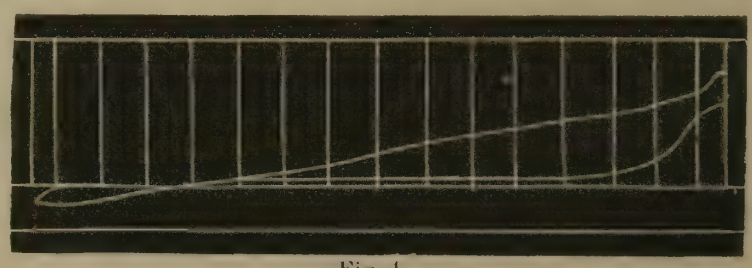


Fig. 4.

this engine. This, however, is the second that the inventor has built, and he naturally objected to altering it during the Exhibition.

We have a friction card shown in Fig. 4, and reading as follows:

M. E. P., 3⅜ lbs.—multiplying by the H. P. value of 1 lb. M. E. P., gives 1·34 H.P.

The horizontal engine shown in the cut is rated at 15 effective H. P. There is an upright oscillating engine, rated at 8 E. H. P., and in which the piston rotations are produced by simpler means than in the horizontal engine described. This last, which is substantially built and well fitted, is supplied with a Judson throttling governor. None of these engines have as yet been put upon the market. G.

TURBINE WATER WHEELS AT THE CENTENNIAL EXHIBITION.

I.

A look at the numerous turbines on exhibition in Machinery Hall, and their elaborate catalogues giving lists of the thousands which have been introduced in this country, gives evidence of a thriving and extensive business; and one can hardly realize that 30 years ago the turbine was scarcely recognized as a motor.

The first wheel of this kind was made in France by a Frenchman named Burdin, in 1827 or 1828, but the real merits of the wheel were not generally accepted till some five years following. Soon after this it began to receive the attention of American engineers, and the first of these wheels of importance was constructed by Uriah A. Boyden in 1844, and introduced into the Appleton Co's Cotton Mills at Lowell, Mass. Tests of these wheels gave remarkable results, the maximum being 92, and the mean maximum 88 per cent. of useful effect from the power of the water.

This extraordinary figure is supposed to be due to the engineer's extreme precaution in polishing the surfaces of the apparatus, using Russia iron guides and floats, and in giving such form to the flume as to impart to the water, as it approached the guides, such a spiral-like rotation as to cause it to enter the guides without resistance. The trials which gave the above percentages decided the great superiority of the turbine over the old breast wheel, and engineers at once saw that, for perfecting water motors, their attention must be turned into a new channel.

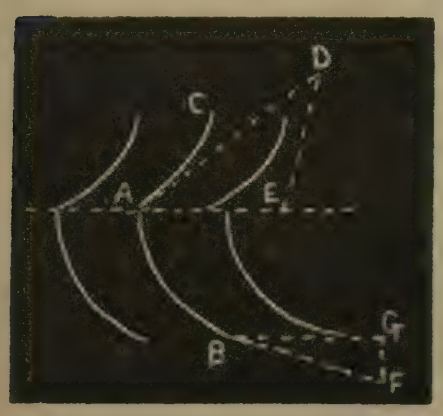
The breast wheel was at once summarily dismissed, and the turbine adopted for reasons unmistakably in its favor, some of which are the following:

1. Increase of percentage from five to fifteen.
2. Greater compactness.
3. Perfect freedom from back-water annoyance.
4. Perfect adaptation of given wheel to all heads.
5. More convenient speed of running.
6. Much less subject to fluctuations of speed.
7. Convenience of installment, and for shipment ready made.
8. Advantages of breast wheel none.

Some of these points are self-evident, but others, such as the 1, 3, 4 and 6, may not be. To help this, and also for the reason that the correct theory of the turbine wheel is but poorly comprehended, as evinced by the forms given the parts in existing ones, the following descriptive exposition of the main theory is given with the hope that practical builders may thereby receive a benefit.

First of all, water *wheels* must receive power from the water by reducing its velocity, and water *engines* by action of its pressure. These points are believed to be sufficiently evident from observation. It is, therefore, obvious that, for a maximum of effect, the water should have the greatest possible velocity due to head in approaching the wheel; and in leaving, the motion should be entirely destroyed. To illustrate, suppose a flat disk be placed square against an isolated jet of water. If stationary, the water will be thrown in all directions without much change in velocity, and no power is developed because standing still. If it moves with the water the stream is not disturbed, and also no power developed. At half the water velocity the vane receives its greatest power, but the water is projected laterally, and for this reason the motion of water is not destroyed, and the maximum of effect is known by hydraulic engineers to be only half the power stored in the moving jet. But this is what may be styled a fair example of percussion, and hence builders of wheels who operate on this principle must expect low returns.

Next suppose the vane be in the form of a hollow half cylinder, and placed so that the jet strikes it tangentially at one side. While stationary, the water is sent around the smooth surface, and escapes, with velocity unchanged, in a direction differing by 180°; and of course we have no power. Giving the vane the velocity of the jet, we get no power again, but with half the velocity of the stream it receives the water with a relative velocity one half its absolute, passes it to issue at 180° unchanged, at which the absolute velocity of the water is zero. Now multiplying the motion of vane by the pressure against it, the result is found to be equal to the whole power of the water. In this example we see that the water is delivered upon the float without shock or percussion, and leaves it without velocity, which principle has long been known in theory as the necessary condition for high percentages. As this has regard to the power of the jet only, the latter should, of course, be made the maximum, by giving the water the highest possible velocity of projection. Of the forms of orifice of projection, the one known, from experiment, to give the greatest velocity is that formed in a thin wall, whose coëfficient, or realizable percentage of the theoretic velocity is about 97. Rapidly converging adjutages give very nearly this, say upwards of 92, while prismatic adjutages give only 82 per cent. Hence a turbine, whose chutes have parallel sides, can only return a percentage of 82, provided the wheel otherwise be absolutely perfect. It is therefore evident that the form of chute is of no whit less importance than the wheel.



Again, in turbines there should be a certain adaptation of chutes and floats to each other, and certain form of wheel passages and exits. The forms most consistent with theory are best explained by aid of the accompanying diagram, which may be regarded as a side view of a Jonval turbine. Let A B represent a float of the wheel, and A C a guide. Let D A represent the direction and velocity of the affluent water, and B F the same, for the issuing water. Take A E or B G for the velocity of wheel, which must be equal, from the nature of the case. The point D should be found by making D E equal to A E, and the direction of D E the same as the first elements of the floats. Then we have D E = A E = B G.

Now if a particle of water moves from D to A, while a point on the wheel moves from E to A, the direction and velocity of the water, relatively to the wheel, will be D E, and hence will enter tangentially upon the float with entire freedom from shock. Compared with the cylindrical vane above, the water will move along the curved float, A B, without change of velocity, and issue with a velocity, B F, equal to D E. But as D E = B G, then B G = B F, and the *absolute* velocity of the water will only be G F. If the water could be made to issue tangentially, G F would be zero, as required for a percentage of 100. Though in practice G F must have a magnitude, it should be reduced to the minimum. The water has also been regarded as having uniform velocity from A to B. That this be possible, the transverse sections through the inter-float passages should be the same at all points. Hence, that the exits be thin, requires them to be long from crown to crown. And again, in order to deliver the water on wheel in direction D A, the last elements of the guides should have the direction D A; otherwise the form should be favorable for high velocity of projection.

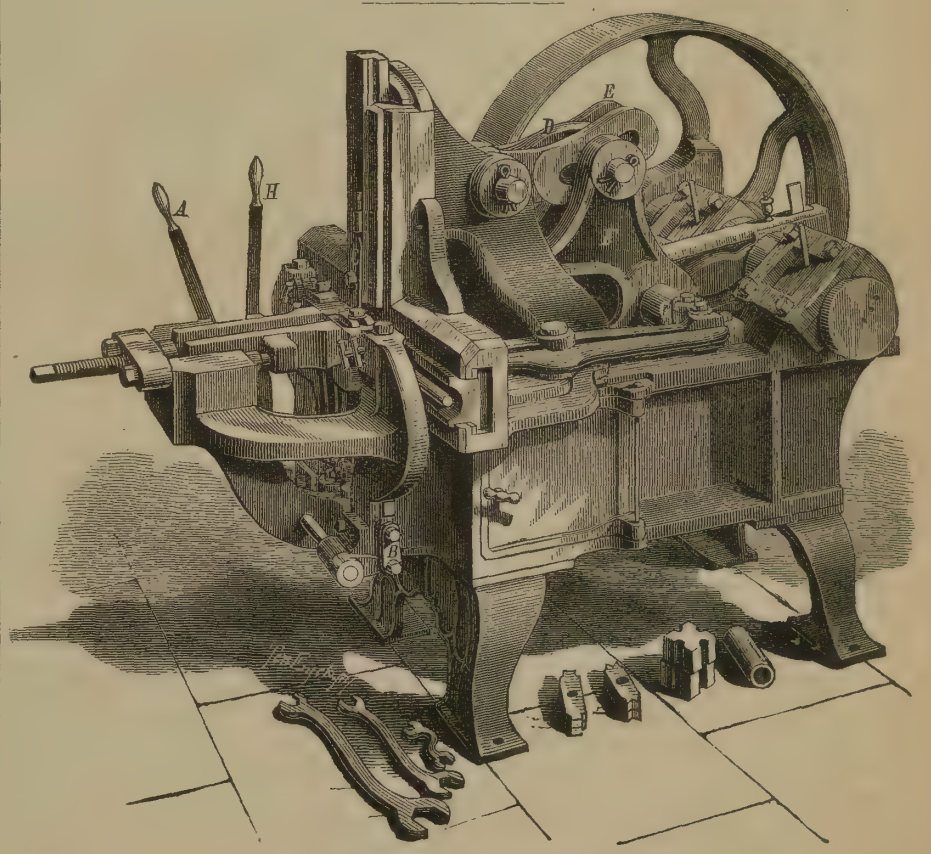
Now this diagram may be greatly varied, and still these principles hold equally well. It is only necessary that D E = A E = B G = B F; last element of guide have direction D A; first element of float have direction D E; and inter-float passages be uniformly large from beginning to exit. The velocity of wheel will be to that of the water as A E is to A D.

When the first elements of float, for instance, are perpendicular to A E, the guide direction A D should be 45°. For float direction A D, 60° to the right, guide direction will be 60° to left, and A D E will be an equilateral triangle. Indeed A D E is always an isoceles triangle.

In designing a wheel it is very important that there be no interference to free passage of water in the curbing and penstock, or in the vent from wheel; and hence these should be large and unobstructed. S. W. ROBINSON.

School of Mechanical Engineering,
Illinois Industrial University.

[*To be continued.*]



THE "ABBE" BOLT FORGING MACHINE.

The accompanying illustration represents a bolt forging machine, made by S. C. Forsaith & Co., Manchester, N. H., and shown in Annex, No. 1, Machinery Hall.

The machine is operated by means of a belt running over a pulley which transmits motion to the main shaft through the medium of a clutch. A fly-wheel is used in connection with the pulley, and is in constant motion, thereby giving to the operating parts the benefits of its momentum instantly upon the engagement of the clutch. A crank on the main shaft gives movement to the forging mechanism, which is of a substantial character, by means of a connecting rod. In the manufacture of bolts by this machine, bar iron is cut to the required length, heated at one end to a welding heat and placed in the holding dies with the cold end resting against the gauge screw which regulates the length of the bolt. In the completion of a bolt the shaft is allowed to make four revolutions, during which the forging dies make twenty-four, and the upsetting devices four actions, the rod being held securely during the entire process. The bolts produced by this machine are claimed to be of a uniform diameter with no increase of size under the head. The working parts of this machine are arranged in a manner to prevent their being injured by contact with cinders or water. Two sizes of these bolt machines are built by the manufacturers, differing in the amount of production and size of bolts, the smaller one capable of turning out 2,500 to 6,000 and the larger one 3,000 to 8,000 bolts per day of ten hours. Heads of any shape may be produced by modifications in the dies.

FIRE PROTECTION.

CONCERNING SPONTANEOUS COMBUSTION.

IV.

With regard to the spontaneous combustion of oily woolen-waste under circumstances analogous to those of the preceding examples, the evidence is likewise very positive. Concerning the occurrence of spontaneous fires in woolen mills, the testimony of Mr. John L. Hayes,* the editor of the *Bulletin of the National Association of Wool Manufactures*, is eminently trustworthy. "The combustion of oily woolen-waste," says Mr. Hayes, "is familiar to all older manufacturers; that the cases do not more frequently occur under the eyes of manufacturers, is due to the precautions now generally in use." He specifies, also, a number of remarkable cases of accidents from this source, which, however, it would be overstepping our limited space to recount. For these details, therefore, we refer the reader to his original paper. He likewise instances cases where spontaneous fires have originated from the woolen rags, overalls, &c., used by painters, varnishers, and workmen in related trades, that had been carelessly thrown aside and left for a time exposed to favorable conditions. Accidents of this kind, it would appear, are of more frequent occurrence with woolen waste than with any other.

With regard to silk, the methods of preparing the fabric from the raw material are attended with no danger. Oiled silk fabrics, however, though perhaps to a less degree than the vegetable textiles, or wool, are nevertheless quite susceptible to spontaneous ignition. A novel illustration of the dangers to be apprehended from this source, was related to the writer from the experience of Prof. John Wise, the well-known scientific aëronaut, who stated that he had on several occasions suffered either partial or total loss of both cotton and silk balloons from their spontaneous ignition.‡ Again, it seems to be well established that black-dyed silk is liable to a similar alteration, although its real cause has not yet been satisfactorily illustrated.

In all the cases thus far advanced, it will be observed, the phenomenon of spontaneous ignition has been confined to substances whose eminently porous texture permitted of the presentation of an enormous surface of the oxidizable portion of the mass, to the action of the atmosphere. Where the predisposition to oxidation exists, we shall find, upon extending our observations, that a highly porous texture, or a great degree of comminution, are such peculiarly favoring circumstances, that they may originate spontaneous ignition in quite a variety of substances. In this connection, we may mention the fact that lampblack, a most highly comminuted variety of carbon, is liable to spontaneous combustion. When freshly manufactured, the great absorptive power for gases, with which it is endowed, aided by the enormous surface it presents to the atmosphere, and its power of selecting the oxygen therefrom, demands that its manipulation shall be governed with extreme caution. The same statements hold good, though to a less degree, with charcoal. The Mr. Braidwood, whom we have already quoted, remarks‡ that lampblack and charcoal are still more inflammable (meaning more so than sawdust, and the vegetable and animal textiles) when the smallest quantity of oil gains access to them, and should not be admitted among ships' stores."

The kinds of wood generally used for the manufacture of charcoal for gunpowder, are the black dog-wood, the willow and the alder. These varieties are all well adapted for the purpose, though for the best brands of sporting powder the dog-wood is said to be preferable. The wood is converted into charcoal by heating it in iron cylinders. After the charcoal is removed from these vessels, it is placed in iron coolers provided with tightly-fitting lids, and allowed to stand for some hours until quite cool. It is then sent to the mill to be ground, and is afterwards mixed with the other ingredients for gunpowder. With reference now to this process, Prof. F. Hargreaves§ vouches that there are many instances recorded where the charcoal has taken fire on the day after grinding. With the process of this occurrence we are by this time quite familiar. This same observer, it appears, is also aware of the fact that the pulverization of the charcoal is not absolutely indispensable for such ignition to ensue, for he adds at the conclusion of his remarks, "The absorption (namely, of oxygen) with sticks of charcoal is not so quick as with ground charcoal, hence the spontaneous combustion of stick charcoal does not occur so often." Mr. Hatfield, in a paper containing "Observations on the Circumstances producing Ignition in Charcoal at Atmospheric Temperatures," published in the Philosophical Magazine, states the following:—"If twenty or thirty hundred of charcoal, in a state of minute division, be put together in a heap, and left undisturbed, spontaneous combustion generally occurs." He records, in verification of this statement, the following instance. "A quantity of small charcoal was thrown into a heap that covered about ten feet square and four feet deep. In three days the temperature had increased to 90° (F.) although it was at first only 57°, that of the surrounding air. On the sixth day it had risen to 150°, and on the seventh, combnstion had commenced in several places."

Dr. C. T. Jackson, in a communication to the American Academy,‖ gives the following piece of testimony corroborative of what has just preceded. "Three times," he remarks, "I have set fire to charcoal at temperatures below that of boiling water. My first experiment or observation was accidental. I was preparing, while at Bangor, Me., for a lecture, in which I had occasion to show an artificial volcano. I took a tray filled with gunpowder and laid it on the stove to dry. I then took a paper of pulverized charcoal, such as is sold by apothecaries for tooth powder, the charcoal being wrapped in white paper, and placed it on top of the gunpowder that was being dried upon the stove. Having occasion to go out, I took off the paper of charcoal and laid it on the table. When I came back, in about twenty minutes, I observed the paper smoking. The charcoal was completely consumed. During all this time, the gunpowder remained on the stove unexploded."

My next observation was this: While at work in my laboratory, I had occasion to use a piece of charcoal for blowpipe experiments. I went down into my cellar, and brought up a piece of light, fine, round charcoal suited for that purpose. It was damp. I laid it upon the top of a column stove to dry, directly beside a tin pan containing water, which was not boiling and never did boil there. I took the charcoal off the stove and laid it on the table. A short time afterwards, I discovered that it was on fire all through its mass. I laid it aside and it burned entirely to ashes * * * * * I repeated the experiment again intentionally, watching it carefully, and with the same result." The explanation of the cases first quoted is not difficult to find. The charcoal possesses wonderful porosity and great power for occluding gases. This absorptive quality is supplemented by a species of selective power, in virtue of which, it absorbs oxygen with much more avidity and in much greater quantity than nitrogen. The enormous condensation which gas suffers by absorption into the pores of the charcoal is attended with the liberation of a quantity of sensible heat that is the equivalent of the work the atoms have accomplished, while simultaneously, the eminent non-conducting property of the charcoal hastens the period of active combustion by preventing the dissipation of the heat thus evolved, and concentrating it upon the porous mass. W.

(*To be continued.*)

* *Bul. National Assoc. of Wool Manuf.* 1869, p. 198.
† Through the Air. Wise, 570.
‡ *Loc. cit.*
§ Jour. Chemical Society, 1874.
‖ Cited in *Sci. American.* (2) xxi, 243.

ON ANILINE.

By PROF. HERMAN POOLE.

II.

Many of us remember the great excitement which Magenta and Solferino created among the lovers of flashy colors. These came into popular notice at about the most interesting period of an European war, and were christened after the two great battle-fields. But the color was known before. Hoffman observed it in 1843, and again in 1858. He paid no special attention to it, however, being then engaged in a different line of research. In 1859, Verguin and the Rénard Brothers of Lyons patented their process for obtaining fuschine. It is obtained by heating aniline with bichloride of tin in a glazed iron vessel at a temperature of 300°. When the mass looks black, it is cooled and treated with a large quantity of boiling water. If required for immediate use this solution can be used, otherwise the coloring matter is precipitated with common salt. The cheapest process for making this color employs arsenic acid. As several cases of poisoning are on record from colors produced in this way, and as the workmen are always in great danger, it is to be hoped that some cheap and available substitute will be adopted ere long. There are many varieties and shades of this color, and they are the most popular ones. There brilliancy, however, is not permanent and pales before the sun. Nevertheless they are produced so abundantly now, and their tinctorial power is so great, that fabrics dyed with them do not command a higher price, as was the case with the carmine tints, and thus their transiency is partly atoned for by their cheapness.

Soon after the manufacture of aniline reds became common, it was noticed that different samples of aniline yielded vastly different quantities of magenta. Hoffman investigated this and found, to his great astonishment, that *pure* aniline would not yield the red at all, neither would pure toluidine; but that mixtures of the two gave the color readily and was necessary to the production. This is the reason why the commercial benzol is not freed from the accompanying toluol, xylol, etc., they playing as important a part as the benzol itself. This is one of the surprising results experienced in the working of these colors. It formed one of the main inducements to study for the theoretical chemist, and since then the study has proceeded, and is still proceeding, with a vigor and zeal rarely, if ever, equalled in any line of chemical research. The field seems unlimited; compound after compound has been discovered and described, until finally, by a comparison and study of them, the theory of the organic bases has arisen—a scientific monument to the perseverance of those who studied and labored in the cause of truth.

The world had hardly welcomed the advent of magenta, when it was called to welcome the Bleu de Lyons, Blue de Paris, and Nicholson's Blue. These were obtained by the action of reducing agents or of aniline on the magenta. Nicholson's process gives one of the most brilliant of these colors, and depends on the action of aniline and rosaniline (the organic base of the magenta) in presence of acetate of potash. It has almost entirely superseded the other blues, except for certain uses; but although its brilliancy is unrivalled, yet its permanency is far excelled by indigo blue. At first the great drawback to its use was in its insolubility. Nicholson finally overcame this objection by discovering that it was soluble in sulphuric acid. A compound acid is thus formed, which is used to dip the fabric in. When dyed thus, if not treated further, they would be of a very faint color; a bath of acetic acid is used, therefore, setting free the compound acid, and the brilliant color reappears as if by magic.

Besides the reds and the violets, there are the yellows, greens, purples, browns, and blacks. They are produced either from aniline itself or from some of the other colors, and serve to show what a vast array of splendor is locked up in that vile-looking compound—coal-tar. Aniline black is one of the most durable and permanent of all the blacks known, and its use has been recommended in the formation of indelible or India inks, and also for purposes of painting. By making a solution of the black in alcohol, to which a little chlorhydric acid has been added, and then mixing it with gum arabic mucilage, an ink will be formed which neither acids nor alkalies will attack, and which does not corrode steel pens. The color is usually made by treating aniline with chlorate of potash, acetic acid and other reagents, and is considered to be composed of at least two simpler substances, one of them being an intense blue. When used as a dye, it is usually necessary to pass the goods through a bath containing an iron or some other metalic salt.

The great affinity all these dyes have for the various animal substances is one of the most strongly marked characteristics. A piece of woolen goods will absorb entirely all the coloring matter from quite a large quantity of water; and silk acts similarly. Dyeing with wool or silk becomes then quite simple, all that is necessary being to get the coloring matter in solution and dip the goods. Some slight differences in manipulation of the different colors are necessary with different classes of goods. For instance, violets need a weak acid, usually tartaric, with silk, and are worked cold; whereas, with wool they need no acid, and are worked hot. The goods need not be in the bath long, fifteen to twenty minutes being usually sufficient. The avidity with which the dyes are fixed by the animal fibres was a great disadvantage at first, it being almost impossible to obtain an even tint. Soapy solutions are now used, and some introduce the dye in small portions at a time.

So much for animal fibre. With vegetable fibre the case is vastly different. Here, instead of a strong attraction for the coloring matters, the reverse exists in just as marked a degree. For a long time this seemed an almost insurmountable difficulty; finally it was discovered that tannin or albumen possessed the property of fixing the color on cotton. Attempts at dyeing the cotton were therefore discontinued, and the attention directed towards printing the colors. In England the cotton is soaked in decoction of sumach (a source of tannin) and then in a tin solution, followed by a bath of dilute sulphuric acid. The color is then applied. Some prefer treating with olive oil and sulphuric acid prior to using the sumach.

The tinctorial powers of these dyes are simply wonderful. If a piece of paper be sprinkled with powdered magenta and then, all that can, be shaken off, a few drops of alcohol will immediately give a deep red color to the paper where they fall, showing that although but a minute portion of the color remained, yet it was enough to make its presence known. Herein lies the secret of the pecuniary success of these bodies. But a very small portion of the crude materials used become available for coloring, yet that small portion possesses so much color, that it will dye a very large quantity of goods. Ten pounds of cotton, for example, require but one ounce of magenta, and only one-half that quantity of pink.

Nearly all the shades are possible and can be produced by slight modifications in the manufacture; and now, if a dyer has a large order for goods of any particular color, he will not attempt to match it himself, but will send to the manufacturer, giving, of course, the method of treatment he will use with the dye. This necessitates the manufacturer's being a dyer, and with these colors a knowledge of the two arts must go together. The dyer and the manufacturer must understand each other's processes in order to produce the best results. Different fibres give different tints with the same bath, and in fact, different varieties of the same fibre will not give the same hue, so that by this means another element in the causes of different tints is introduced. One great difficulty attending the use of these colors lay in the fact that they were different from any others in use. The coloring matters of the vegetable world are acids, weak ones, to be sure, yet they are acids, The coloring matters of the aniline series, on the contrary, are bases, and some of them quite strong ones. Here then was need of new processes for using them, and the new processes were invented, new apparatus was needed and it came forth.

Calvert says that color is the soul of tissues. What a brilliant, joyous soul must the tissues of to-day possess; and what an effect they must have on the soul of the wearers! Is not a marked difference due to this apparent in the present generation? Does not the association with lively colors tend to elevate, and make joyous the individual? Are not pleasing tints always associated with pleasing thoughts and memories? Let us not forget, while enjoying these colors, the hours spent by such men as Perkin, Ballard, Liebig, Kuhlman, Hoffman, and a host of others, in their efforts to produce them and to place them within the reach of all; and let us remember that although most of them worked for the advancement of theoretical chemistry, yet their results, like that of many more of the same class, redounds to the good of the human race. Let us remember that, but for them, the colors of the rainbow, stored up in the coal deposits of the antediluvian forests, would still remain in obscurity, and that the great revolution in the arts of dyeing and color printing would yet remain to be brought forth in the unknown future.

Buffalo Practical School, August, 1876.

IMPROVEMENT IN THE CONSTRUCTION OF SUBAQUEOUS TUNNELS.

Mr. John C. Trautwine, Civil Engineer, of this city, has recently secured a patent for an improvement in the construction of subaqueous tunnels. At the present time, when so many tunnels are being projected beneath the beds of rivers, or even of arms of the sea, any suggestion for diminishing the labor, expense, or well-known hazard of such constructions, is especially opportune. Mr. Trautwine's proposition is somewhat startling, from its novelty; but so far as we can venture to express an opinion based upon a merely cursory consideration of the subject, it certainly appears to us that in many cases it would be a great improvement over the usual processes. The subject, however, is not so simple as it might at first sight appear to be; for different circumstances of locality would evidently require important modifications in the details of his process in order to adapt it to the controlling peculiarities of any selected site of the tunnel. Our time does not permit us to examine or discuss these matters of details; indeed they pertain rather to the province of the civil engineer; we will therefore limit ourselves to merely stating the *general principle* of Mr. Trautwine's invention, and to pointing out some of the more obvious advantages resulting from it.

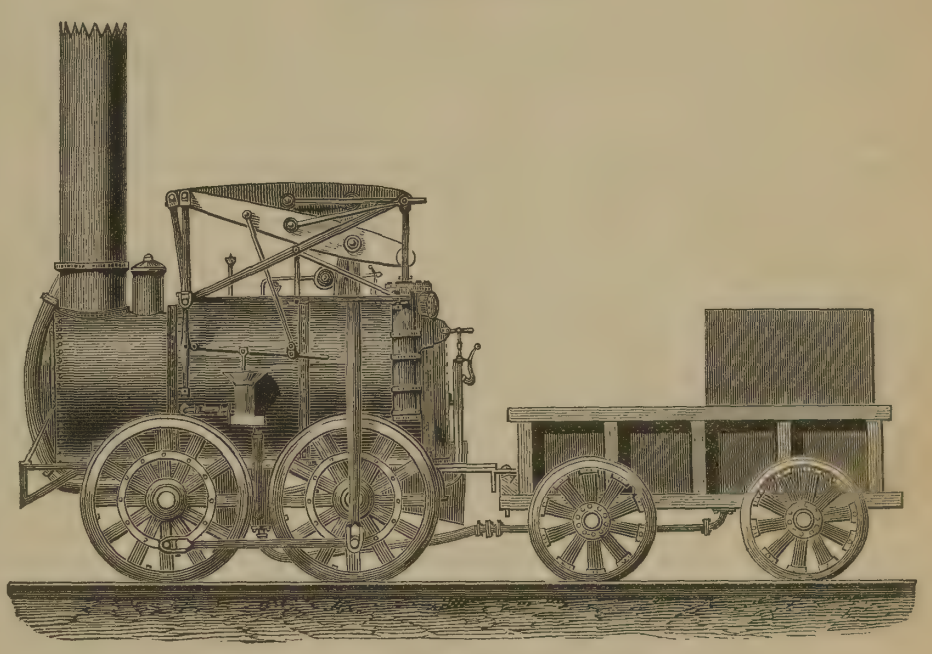
His broad proposition is to abandon the usual method of perforating the tunnel beneath the bed of the stream; and to construct it above water, upon a strong solid wooden platform several feet in thickness, which shall serve as a base for it to rest upon after it is finally dep sited in its place. The tunnel and its platform are then to be sunk into a trench dredged across the bed of the stream for their reception. The depth of the trench may vary with circumstances; in some cases it may be so deep, that when the dredged earth is thrown into it again, the top of the tunnel will be entirely beneath the original bed of the stream. This will evidently be necessary when the full natural depth of the stream is required for navigation. When this is not the case, and the depth of the stream admits of it, the tunnel may be but partly beneath the bed, or may even rest upon it. In either case, the tunnel may then, if necessary, be surrounded and covered with earth and rough stone, to protect it from ice or other floating bodies, or from dragging anchors, etc.

When the bottom of the trench, or of the river bed, is soft, piles would generally be driven for the wooden base of the tunnel to rest on. But as before remarked, we cannot discuss in detail the great variety of modifications which circumstances may require, not only in the tunnel itself, but in the preparation of its foundation, the processes for sinking it into its place, etc., etc. Engineering science possesses abundant resources for meeting them all.

Only a very short tunnel could be sunk entire. A long one would be made and sunk in sections of perhaps one hundred, or more, feet in length; and the short intervals, or joints between these sections could afterwards be filled up by means of divers or by coffer-dams, caissons, etc. In water of moderate depth, the sections may be at once built on the very spot they are to occupy, by means of coffer-dams. The most prominent advantages that present themselves to us in Mr. Trautwine's method over the common one are, first, the avoiding of the danger to the lives of the workmen (together with the delays and expenses) attendant on the breaking in of the river bottom; or the sudden irruption of quick-sand, or springs of water. Second, that inasmuch as the tunnel need not be placed at so low a level, its excavated approaches may be materially shortened, at a corresponding saving of expense. For instance, if the top of an ordinary tunnel has, for safety, to be placed say thirty feet below the bed of the stream, and if the excavated approaches to it be on a grade of one in fifty (or 106 feet to a mile) it is plain that the approach to each end must be 30 times 50 feet longer than would be necessary if the top of the tunnel were at the bed of the stream. In other words, the two excavations for approaching the tunnel by the old method must together be 3,000 feet longer than for one built on Mr. Trautwine's plan. If the more desirable grade of one in a hundred, (or 53 feet to a mile), be adopted, the difference becomes six thousand feet, or more than a mile, in favor of Mr. Trautwine's plan; and where the top of the tunnel can be placed *above* the bed of the stream, the difference will be still more in his favor.

Another advantage in his method is that it obviates the necessity for the extreme care that must be taken to secure a perfect alignment for the tunnel, in order that the two halves of its length, (commenced at its two ends) shall meet at its centre.

We may have more to say on this subject in a future number. G.



THE STOURBRIDGE LION—A RAILROAD RELIC.

THE STOURBRIDGE LION—A RAILROAD RELIC.

Among the mechanical curiosities exhibited at Philadelphia are a walking beam, wheel centres, and a few other details, all that remain of the old locomotive "Lion," which ran for the first time upon the railway of the Delaware & Hudson Canal Company's railway on the 12th of June, 1829. This railway was the third built in America, the first having been constructed near Quincy, Mass. This was three miles in length, and was commenced in 1827. The gauge of this road was 5 feet, and the rails consisted of pine 12 inches deep, covered with oak planks, and protected by flat iron bars. The rails were laid upon granite sleepers, 7 feet 6 inches long, and placed 8 feet apart. The second railroad was commenced later in 1827, and extended from the Mauch Chunk coal mines to the Lehigh River, 9 miles distant. This was a gravity worked line, the empty cars having been hauled up by mules.

On the 4th of July, 1828, the works of the Delaware & Hudson Canal Company's railroad were commenced, and Mr. E. L. Miller, of Charlestown, and Mr. Horatio Allen were sent to Europe to study what was being done at that time in England. During their stay, Mr. John B. Jervis, then Chief Engineer of the Delaware and Hudson Company, sent over orders to procure rails and three locomotives for the new work.

These instructions were duly carried out, and the "Lion" was the first of the three engines shipped to New York, where it arrived about the middle of May, 1829. The accompanying illustration shows the arrangement of the engine. It had four coupled wheels, 4 feet diameter, driven hy two vertical cylinders, with 36-inch stroke, placed at the back, on each side of the boiler. The motion of the piston was transferred through two grasshopper beams to the connecting rods and crank pins in the wheels. * * The machine was built by Messrs. Foster, Rastrick & Co., of Stourbridge. After some time the engine was abandoned on account of the imperfections in the road, and it was finally taken to pieces and the different parts utilized. The boiler was worked for many years afterwards.—*Engineering.*

[We beg to acknowledge our indebtedness to "*The Railroad Gazette*" for the accompanying engraving.]

☞THE REVIEW ON TRIAL.—The subscription price of THE POLYTECHNIC REVIEW is but $3. per year, including postage. In order to afford every one an opportunity to give the paper careful inspection, before subscribing for a year, we have determined to send it to any address for four weeks, including and following our next issue, for TWENTY-FIVE CENTS, which will include postage. To any one getting up a club of ten such subscribers, and remitting $2.50 therefor, we will send a copy free during that period.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The Steel Rail Mill of the Vulcan Iron & Steel Works, of St. Louis, the erection of which was begun about a year ago under the direction of A. L. Holley, C. E., is now completed. Mr. Holley is acknowledged to be the best authority on Bessemer plant, and as all the best and latest improvements have been adopted in these works, the plans have been placed on exhibition in the rooms of the Civil Engineers' Association in the West Gallery of the Main Building at the Centennial Exhibition. The Vulcan Works consists of three blast furnaces, one iron rail mill and steel plant with steel rail mill complete, also machine shops and foundry for doing their own work. They give employment to more than one thousand men, and have capacity for making seven thousand five hundred tons of rails and four thousand tons of pig metal per month. The favorable location of the works for the shipment of their product, gives them the best advantages. Among the first orders for steel rails is one from the Central Pacific Railway of California. The Vulcan Iron & Steel Co. is now prepared to enter the field of competition on as good, if not better footing than any mill East or West. It starts out with a good supply of orders, and there seems to be no reason why it should not be a continued and grand success.—[*R. W. Review*, xiii, 44.]

Quick Work in a Car Shop.—The Scranton (Pa.) *Republican*, speaking of the change of gauge on the Delaware, Lackawanna & Western Railroad, says: "The work of narrowing the coal cars to suit the altered gauge of the road, still progresses briskly at the shops in this city. The number that have undergone the necessary change since the middle of last March amounts to 5,472 cars. The cars are turned out at the rapid rate of from 50 to 55 per day. The men are aided by the most perfect machinery. During the busiest period intervening since March, the most remarkable day's work—accomplished in 24 hours—was to remove and replace 164 pairs of wheels, cut the axles, and have them in complete order within the short space of a day and a night. About 900 men have been steadily employed since March."

Endless Rails.—A trial was lately made in Paris, of the so-called endless-rail of M. Clement Adar, and according to account, with very satisfactory results. The operation of the system is thus described. Three small carriages made up into a train circulate on a line of way formed by articulated rails, which are raised after the passage of the carriages, and are laid down again in front of them. The train, propelled by steam or horses, may, at the will of the guard take any direction, and may even run over treacherous or sandy ground. The authorities have interested themselves in the subject and further experiments will shortly be undertaken. [*Jour. Society of Arts* xxiv, 894.]

—Less dredging work was required at Port Said last year than in 1874. The quantity of stuff dredged out of the great Ismail Basin at Port Said in 1875 amounted to 190,000 cubic metres; the removal of this stuff secured the basin its maximum depth throughout. The maintenance of the sidings and bed of the canal last year involved the dredging of 721,000 cubic metres. The quantity of stuff removed in 1875 between the two seas only amounted to 52,700 cubic metres. The quantity of stone used during the year in facing banks amounted to 24,500 cubic metres. The canal was navigated with facility last year by steamers drawing nearly 27ft. of water, and 430ft. in length. [*The Engineer*, xlii, 79.]

—The work of clearing the new channel at Eagle Harbor, Lake Superior, will soon be completed. It is 60 feet in width, and will be marked by range buoys. The next work in hand at that point will be the deepening of the old channel, and when this is finished there will be a uniform channel 120 feet wide, with sufficient depth to enable craft of the largest size to enter the harbor.

—Sir John Hawkshaw, on examination, pronounces the Lake Huron and Ontario ship canal feasible. If this canal should be constructed it would save between 300 and 400 miles from Chicago to all points on Lake Ontario, and much dangerous navigation.

—Work has commenced on the water works improvement at Oregon, Ill. The race is to be 340 feet long, 50 feet wide, and 15 feet deep, with walls of four feet thickness, and will be completed about Nov. 1st. There is a splendid water power at this point awaiting development.

—Judge Johnson has rendered his decision denying the motion for an injunction to restrain the further construction of the New York & Brooklyn bridge, on the ground of obstruction to navigation. In consequence work has been resumed with great activity.

—The *Telegram* says that Hell Gate is to be exploded positively on the afternoon of Tuesday, September 5th. The explosives used will consist of nitro-glycerine, dynamite and rendrock—65,500 pounds in all. All the discharges will occur simultaneously. To obviate any severe shocks, as well as to render the blast as effectual as possible, the excavations are to be flooded with water.

—On August 8th, the Chair laid before the Senate a communication from the Secretary of War, inclosing a letter from the Chief of the Engineer Corps, remonstrating against the proposed amendment to the River and Harbor Appropriation bill, limiting the availability of the appropriation for the improvement of the Southwest Pass of the Mississippi River. He expresses the opinion that, if the amendment should be finally adopted, it will stop the work of dredging, and interfere with the commerce of New Orleans. In the present uncertain state of affairs at South Pass the precaution of the Chief of Engineers is undoubtedly proper. [*Eng. News*, iii, 259.]

—On August 1st, the first stone of the new locks of the St. Mary's ship canal was laid with appropriate ceremonies, Gen. Wetzel inspected the stone, pronounced it properly laid and indulged in a speech, which was followed by others, all agreeing that this canal is destined to be the way of a mighty commerce. The business through this canal in 1875 was 1,290,729 tons. The locks are built on a new plan, and the sluice-ways are situated under the floor, the filling of the lock taking place from the bottom.

—At a meeting of Chicago and Clinton capitalists, at Clinton, Iowa, August 4th, a company was formed to construct a pontoon railway and wagon bridge across the Mississippi, under the act of congress passed two years ago. The bridge is to be similar to the one at McGregor. There will be $100,000 stock; nearly that amount is already taken. Engineer J. E. Blunt, of Chicago, is engaged to make surveys at once and locate the bridge. It is expected to build it within the next few months. The bridge, besides affording wagon way across the river here, will give the Prophettown branch of the Burlington railway and the Western Union railway entrance to the city, previously denied by the Northwestern Railway Co., controlling the present bridge. [*Eng. News*, iii, 259.]

—In regard to the cut-off on the Mississippi at Vicksburg, the *Herald* says: "Just as we predicted before it occurred, the cut-off has been a benefit to the city instead of an injury. It has relieved the suspense in regard to the matter, without inflicting, as yet, the least damage, and with nothing worse to fear in the future than possibly a small outlay to keep the harbor clear."

—Three engineers, under the supervision of Mr. E. C. Clark, are now engaged in surveys for the proposed new main sewer in Boston. One is at Moon Island making surveys, another making observations with reference to the currents prevailing in the harbor by means of floats, while the third is employed in artesian borings to determine upon the feasibility of tunneling the Neponset river. Mr. Clark, the engineer in charge, was resident engineer of the Detroit tunnel, and of the last tunnel under the city of Chicago. He has also been connected with sewer work at Chicago and in Philadelphia. [*Eng. News*, iii, 270.]

—The water system of Dubuque is quite a novelty. In one of the bluffs a lead mining company met obstruction from water, and to obtain relief the bluff was tunneled, when it was found that a copious fountain had been struck which ran to waste for several years. But the water was most excellent, the supply exceedingly liberal and the head so elevated that the idea of utilizing it was seized by a company, the property purchased, and a system perfected which gives the cheapest and best water supply known in the country, furnishing the city for all purposes at an expense of $8000 per year. There is also a sufficient supply to be used for water power. [*Eng. News*, iii, 270.]

—We learn from the Providence *Bulletin* that the Cornish pumping engine at Pettaconset seems to be fully justifying the anticipations of its projectors. For some days past, with the use of Cumberland coal, delivered at a cost of five and a half dollars, the engine has been quietly doing a duty of 95,000,000. All the indications so far are that, as a permanent, reliable, economical pumping engine, it has probably no equal in the country. It is encouraging to learn in this connection that the experimental filter basin at the pumping station, which comes into use with the new engine, promises to afford all the water needed for the present supply, without further drawing direct from the river. [*Eng. News*, iii, 270.]

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Mineralogical.—Krause gives the name of Reichardtite to a massive mineral having the composition of Epsom salt, and occurring in the Stassfurt mines.

—Greiner defines steel to be "all malleable irons obtained in a state of fusion," or, what is the same thing—all cast malleable irons.

—It is estimated that the value of the diamonds found at the Cape from March, 1867, to December 31, 1875, exceeds twelve millions pounds sterling.

—The Spanish Government has appointed a commission to inquire into the physical conditions and possibilities of the Philippine Islands. A professor of botany is to accompany the expedition to report on the nature of the flora of the interior, and on the condition and extent of the forests. A careful survey is to be taken of the entire group and a map, drawn up on a large scale, is in consequence to be published. The mountain ranges are to be the objects of a special investigation; the height of all the salient points is to be accurately ascertained, and all traces of metallic products to be noted. The officers in charge of the expedition are to take such notes of observation as shall enable them on their return to draw up an exhaustive monogram on the entire physical condition of the islands. It is to be expected that many branches of scientific inquiry will profit by this research in a so long neglected and most interesting region.

New Engraving Process.—Messrs. Leitch & Co., it is said, are now successfully practicing a new process, which has not hitherto been carried on here, The drawing is done on glass, covered with a thin etching ground, which is of a pale green color, and so thin that it can be removed with the finest etching point, thus allowing of the most delicate lines being drawn. By placing a sheet of black paper underneath, the artist can perceive at once the progress and effect of his work, the lines of which appear in their natural black. This plate, when finished, is treated as a negative, and a photograph obtained from it, say on zinc, from which a surface block is got in the ordinary way. The great advantage is the possibility of seeing how the work proceeds, for in several processes this cannot be done, and the artist finds, when he has finished his drawing, that it looks very different from what he expected or intended. [*Sci. Am.*, xxxv, 134.

Artificial India Rubber.—A cheap and useful substitute for India-rubber is prepared by mixing a thick solution of glue with tungstate of soda and hydrochloric acid. A compound of tungstic acid and glue is precipitated, which, at a temperature of 86° to 104° Fah., is sufficiently elastic to admit of being drawn out into very thin sheets. On cooling, this mass becomes solid and brittle, but on being heated again, soft and plastic. This new compound can be used for many of the purposes to which rubber is adapted. [*New Remedies*, v, 254.]

Artificial Ivory.—The patent taken out by B. S. Cohen, of London, thus describes the method of the manufacture of this article. Ivory-dust is boiled with water to a jelly, and to this is added some shellac dissolved in alcohol, and some oxide of zinc. For every pound of ivory, 1 oz. each of shellac and zinc oxide is taken. The pulpy mass is poured into forms, allowed to become dry in the air, and then subjected to hydraulic pressure. The finished material may be cut, sawed, and turned as well as natural ivory or bone. [*New Remedies*, v, 256.]

Rusting of Iron.—It is generally supposed that the rusting of iron depends principally on moisture and oxygen. It would appear, however, from Dr. Calvert's experiments, that carbonic acid is the principal agent, without which the others have little effect. Iron will not rust at all in dry oxygen, and will rust very little in moist oxygen, but very rapidly in a mixture of moist carbonic acid and oxygen. If a piece of bright iron is placed in water saturated with oxygen it will rust very little, but if the water contains carbonic acid oxidation takes place so rapidly that a black precipitate is produced in a very short time. It is known that bright iron placed in a solution of caustic alkali does not rust at all. Hence it may be concluded that the oxidation of iron may be easily prevented by the absorption of moist carbonic acid. [*Moniteur Industriel Belge*, July 1, 1876.

An Improved Amalgamating Apparatus separates the gold from sand, etc., by means of a suction air-blast, and carries it into amalgamating pans filled with mercury. Patented July 4, 1876, by T. W. Irwin, Port Madison, W. T.

—A new department of the University of Michigan at Ann Arbor, the School of Architecture and Design, will be opened for the first time with the coming college year.

Prizes for a New Bleaching Agent.—A Vienna industrial league offers a silvers medal to any one who will discover a method of bleaching every kind of silk perfectly white without the use of sulphur or other chemical injurious to silver. In embroidery and silver lace, where silk and silver are used together, the silver is blackened by the sulphur in the silk. A similar prize is offered for the most beautiful and solid domestic article for weighting light-colored silks. [*Sci. Am.* xxxv, 130.]

Glass Circle for the Measurement of Angles.—Mr. Lewis M. Rutherford, whose ruled diffraction plates, as substitutes for prisms in certain classes of spectroscopic work, have gained him a very extended reputation, in 1870, proposed a glass scale for the measurement of the angles of astronomical photographs. It was to be read by a micrometer microscope, and fitted with a gravity slide with one V and one flat slide. He has now carried out the idea by constructing a glass circle about 10 inches in diameter, divided to 10 minutes of arc, adapting it to a spectrometer similar to the one used by Mascart, and described in his paper on the measurement of wave lengths. The measurements were read by two microscopes each magnifying 75 diameters. This arrangement is one of the most delicate mechanical refinements that has come under our notice. [*Sci. Am.* xxxv, 133.]

Manufacture of Inks, called "eternal."—Mathieu Plessy, Three points are proposed:

1st. The use of an ink consisting of some organic substance, as glucose, caramel, &c.

2d. Treatment with some acid salt, which, by heating, &c., will carbonize the organic substance of the ink, without seriously affecting the paper or parchment.

3d. Heating the paper, to effect the above mentioned carbonization. [*Am. Chemist*, vi, 466.]

Phosphor-Bronzes.—The following analyses of specimens of phosphor-bronzes show that phosphorus enters into them in very small proportion, though it has a most useful effect.

Copper	93.68	94.11	90.86	94.71	90.34
Tin - -	5.82	5.15	8.56	4.38	8.99
Phosphorus	.17	.21	.19	.55	.76
Zinc - -	.34	.23	—	—	—

Phosphorus may be introduced directly into the alloy in a state of fusion. In this case a great part of it is lost; only a small quantity combines chemically with the metal. The copper may also be melted in a crucible, lined inside with bone-ash, nitric acid, and charcoal. This mixture should surround the copper on all sides before the closing of the crucible. [*Revue Industrielle* vii, 280.]

New Compensating Pendulum.—Prof. J. Lawrence Smith has recently invented a new compensating pendulum, in which he avails himself of the great expansibility of ebonite, which, between 32° and 158° Fah., approaches that of mercury. The pendulum rod is of steel, with an adjusting screw at the lower end; and a round rod of vulcanite, with a hole in the center, is passed on to the steel rod by fitting it loosely and being held in place by the adjusting screw. The bob of the pendulum consists of a heavy piece of brass, with a hole through the centre large enough to admit the vulcanite, over which it passes, and, by a properly arranged stop, rests on the end of the vulcanite furthest from the lower end of the pendulum, so that any expansion of the vulcanite elevates the brass bob, thus compensating for the downward expansion of the steel rod and brass bob. Professor Smith says that four months' use of this pendulum on an astronomical clock has given very satisfactory results. It can be adapted, at a cost of 20 cents, to the ordinary mantlepiece clock, the pendulum of which usually beats in half seconds. [*Sci. Am.* xxxv, 133.]

Use of Salicylic Acid for Preserving Milk.—A. Pouriau.—Experiments at the Agricultural School, at Grignon, show that milk is well preserved by the addition to it of six grammes salicylic acid to the quart, at a cost of only a quarter of a cent. [*Moniteur Scientif.*]

To Bleach Sponge.—Soak it well in dilute muriatic acid for twelve hours. Wash well with water to remove the lime, then immerse it in a solution of hyposulphate of soda, to which dilute muriatic acid has been added a moment before. After it is bleached sufficiently, remove it, wash again, and dry it. It may thus be bleached almost snow white.

A Green Pigment is obtained by Casali by calcining an intimate mixture of one part of bichromate of potassa and three parts of baked gypsum. A grass-green mass is obtained, which, on boiling with water or mixing with dilute hydrochloric acid leaves a fine powder of an intense green color.—*The Lowe Water Gas process* has been introduced at Manayunk, a suburb of Philadelphia, and the town in question, as well as several others in the vicinity, are lighted exclusively from the new works. A detailed report of the operation of the new establishment will shortly appear in in this journal.—Martenson suggests ammonium salicylate as a substitute for the acid in medicine. He affirms that it is quite as efficacious, and being soluble in water, is more readily administered.

MISCELLANEOUS.

Imitation Marble.—Carl Boschau says that if a statue, made of plaster of Paris or *papier maché*, be coated with thick white dammar varnish, and then dusted with pulverized glass, it will have, when dry, the appearance of alabaster. If it be afterwards varnished a second time, and dusted with coarsely pulverized white glass or mica (*marienglas*) and again dried, it will be a very successful imitation of Carrara marble, especially if the marble veins be first traced with some delicate blue pigment. This method of preparation follows that of Nature, for alabaster consists of very small crystals of sulphate of lime, and Carrara marble of somewhat larger crystals of carbonate of lime, which in reflected light glisten like white sugar. This effect is obtained with perfect deception by the brilliant white glass in coarse powder.

Sewage at Trowbridge.—M. Fulda, a French chemist, has been experimenting with the sewage at Trowbridge. The sewage flows into a tank in which an agitator is worked by a small steam engine to keep certain chemicals in operation. The contents flow off at a two-inch fall into another tank, where the solid portions of the sewage are rapidly precipitated to the bottom, and the effluent water runs into another tank, where further precipitation takes place, and the water flows thence clear and bright into the river. The expense of the whole apparatus is at the rate of 2*l.* for every million gallons of sewage, the residium forming a portable manure. M. Fulda's system is in operation at the cloth mills of Messrs. Pratt and Sons, at the Bromley Union Workhouse, and other places. The cost of a plant to work his process M. Fulda esimates at 320*l.* [*Engineering*, xxii, 109.]

Encroachment of the Sea.—Since the commencement of the Madras harbor works the sea has been gradually but steadily encroaching on the beach at Royalpooram, and a groyne to the north of the railway-shears, round which one could pass dry-shod a few months since, has now some 6 ft. of water at the end of it. One result of the continuous scour which is going on is that a large number of iron rails, the property of the Madras Railway Company, have been disembedded. These rails must have been dropped where they are now being found about the time of the commencement of railway operations in the Madras presidency. [*Engineering*, xxii, 113.]

Dental Gardening.—Miss Adalia L., aged 28, nervous temperament, very healthy and robust, consulted me on May 10, 1876, in reference to trouble with left superior second bicuspid. I found, upon examination, a large cavity upon posterior surface, high up under the gum, with exposed pulp and considerable inflammation, attended with severe pain. The cavity being extremely difficult of access, and the patient preferring not to take the chance of possible trouble after a painful operation, I extracted it. A moment after I proposed to her, partly in jest, to fill and replace it. She agreed, and after excavating, etc., I filled the pulp canal with oxychloride and cotton fibre, and the other cavity with amalgam, and then, carefully rinsing the socket first, the tooth was carried up gradually into the alveolus, carrying with it a piece of silk, which was laid longitudinally along the root, in such a manner that, when the tooth was nearly in place, the gradual drawing out of the silk furnished a vent for the escape of air or water confined above the root. Previous to replacing, about one sixteenth inch of the tip of the root was excised, as it was curved considerably. Pain followed for five minutes, after which the lady closed her teeth forcibly, and with a snap, without any feeling of discomfort. She was directed to avoid using it for a day or two, and then report. Ten days after, May 20, she came in and stated that for a couple of days there was some soreness, since which time she had eaten on that side of the mouth without trouble, and at the time of examination the tooth was as firm as the contiguous ones. No ligatures were used to keep it in place at first, as reliance was placed upon the antagonists in the lower jaw. [*W. E. Hyde, Danielsonville, Conn., in Dental Cosmos.*]

Preventive of Hydrophobia.—In a letter published in a recent number of Professor Gubler's *Journal de Thérapeutique*, another addition is made to the already formidable list of prophylactics against hydrophobia. Dr. Grzymala, of Krivoe Ozeroe, Podolie, reports that during the last ten years he has treated at least 100 cases—in human subjects as well as beasts—of bites by hydrophobic animals with the powdered leaves of *xanthium spinosum*, with success in every case except one, although cases of bites inflicted at the same time, but treated in other ways, had terminated in death. The drug is described as possessing sudorific, sialagogue, and slightly diuretic properties, but less pronounced than those of jaborandi. The dose for an adult is 9 grains of dry powder of the leaves, repeated three times a day and continued during three weeks; to children under 12 years, half the quantity is given.

German Amber.—The extent of the amber fields in Germany may be seen from the fact that twenty-two dredges, two tug-boats, one hundred barges, and one thousand laborers are engaged in the industry. The area of the amber field is extensive, and the Government derives from it a yearly rent of 72,200 thalers. [*New Remedies*, v, 254.]

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This is one of the very best of our engineering exchanges; and we evince our appreciation of this fact, by drawing on it perhaps more liberally than upon any other single journal of its class, in making up our "Review matter." It has good editorship and influential backing, being the official organ of the Civil Engineers' Club of the N. W., and of the Chicago Chapter, A. I. I.

INDUSTRIAL.

THE AMERICAN WATCH.

WALTHAM has become, in a double sense, an American *watch* word; First, because a town distinguished for the rapid and eminent success of a great American industry; and second, because inscribed on a majority of American made watches. Here the first American company was organized for the manufacture of watches, and here it has its permanent location.

The time was, and not long ago, when no one dreamed that watches could be made in this country, and how surprised were those who first beheld an American watch as an established fact. When this fact could be no longer disputed, the quality of such watches was questioned. But the season of doubt was short, as those familiar with the good qualities of American watches can attest.

Watches were first made in America about twenty-five years ago, but it was not till about 1857, that watch-making could be considered as an actual American industry. Every one is familiar with the remarkable strides which this business has made since that period. We may get a little idea of the present status of *the American Watch Company* and its business from the fact that a complete watch is turned out in every one and a-half to two minutes of the ten hours of daily work-time or 350 to 400 watches per day; while for the last few months, the rate of production has exceeded the latter figure. What becomes of this annual production of more than one hundred thousand? We answer that the business can never stop till every American has his home-made watch, and foreigners, who also are beginning to fully appreciate the good qualities of these watches, are to a great extent supplied. For some time a market has been established in London, England, one of the strongholds of European watch-making, and the foreign sales of American watches has now become a very considerable part of the Waltham watch trade.

When we take note of the fact that American and European markets are filled with watches of European make, of all prices from five or ten dollars to several hundred, and that these are made by hands skilled for a lifetime and in communities which have been schooled for centuries for the task, the wonder is that the American trade could have obtained any foothold at all. This mystery is only solved by going down to the methods and processes adopted for production, and ob serving somewhat in detail their various points of excellence.

First of all, the American is pre-eminently a mechanical man. When a piece of work is to be undertaken, great or small, the first inquiry is how can I diminish the cost and improve the product by machinery? To answer this judiciously, was the first great problem of the WALTHAM WATCH COMPANY.

Not only does the American seek to produce by machinery, with a view of gaining rapidity of production, but the time consumed in fitting and trying must be reduced to a minimum. To this end it is necessary that the parts be interchangeable, so that when a piece is once right, millions may be made like it with certainty of fitting their places. This is carried out most admirably in the Waltham factory, any piece of any watch of given pattern fitting precisely in any other of its kind.

In the use of machinery there may be extravagance as well as in other matters; and the application of machinery is often a failure from this cause. We may ask too much of it. When by complicating a machine we add to the cost of production more than the manual labor saved, then we pass the limit of economy. Therefore, the kind and cost of labor saved should always form part of the reckoning in designing a machine.

A visitor at the Waltham factory is struck with the character of the machinery employed there. No large proportion of it can be called wholly automatic, but it is all labor-saving machinery in the strictest sense; in fact just that judicious combination of automatic action, fed, assisted and watched by attendants, which secures on the whole the most economical results.

In this way the machines may be said to serve as guides for the hand, causing the tool to describe certain parts with precision, and by which the same accuracy is secured as by automatic movements. In fact the difference in purely automatic machines, and the above described devices, consists mainly in the matter of feed of the tools, and hence to quadruple the cost of a machine for such an unnecessary object seems extravagant, unless there be a corresponding gain in rate of producing or possibly quality of product.

In the Machinery Hall of the Centennial Exhibition, near the great Corliss engine, may be seen in actual operation several of the Waltham watch machines, which serve to give a fair idea of the nature of the machines employed at the Waltham factory. These machines are only partly automatic, and operated mostly by girls. They represent screw-cutting, gear-cutting, pinion-cutting, pivot and jewel forming, besides polishing and turning machines, some two dozen in all. They are taken from the work-rooms of the factory, and serve to give a fair idea of the machines actually used there. All show novelty of design and exquisite workmanship. While beholding this scene of workwomen and machines all employed to make screws, jewels and single wheel and pinion only, the observer obtains but a faint idea of the amount of machinery and number of operatives necessary to make a single complete watch, after the manner of the American Watch Company; much less can one picture to himself the ocean of machinery employed to produce the sixty different watches manufactured by the company, varying from the most delicate "lady's" to the heaviest "hunter's" watch. These are contained under the roofs of the buildings of the Company, inclosing nearly two acres.

The Company not only employs machinery for executing the running parts or the "movements," but for doing the work required for completing every part of their finished watch as found in the market, including the whole range of operations from the first stroke of cutting from the metal plates and wires to the tempering and adjustment of the most delicate hair-spring. Thus the idea entertained by some, that the Company must be dependent upon foreign aid for some of their more delicate parts, is seen to be groundless, and this will seem all the more ridiculous when we learn the fact that the Waltham Company has so far excelled the watch-makers of foreign countries in this as to utterly astonish them, not only with the high degree of perfection attained in the finish and quality, but for the means employed for so forming these parts as to guarantee great excellence of the watches as time-pieces. Indeed, this feature of the Waltham watch-making is so important, that to tarry a little with it may not prove wholly without interest.

The merest amateur knows that the time-keeping qualities of a watch depend more upon the parts concerned in the escapement than on any thing else. These parts consist of the escape wheel, the lever, the balance wheel with its staff and roller plate, and the hair-spring. Of these the hair-spring and balance play by far the most important parts; as regards these two pieces, the fine adjustment required by each for accurate time-keeping is entirely distinct from the other. With the balance-wheel the compensations for changes of temperature are made, while with the hair-spring the watch is made isochronous, and each of these is of the highest importance for the best of time-keeping. To train these two parts of a watch to complete adjustment requires great care, experience and patience, involving much expense, and to this the great cost of the higher priced watches is chiefly due. Although these delicate qualities are paramount for the best results, they are among the most invisible. Indeed, of two watches, one worth $50, and the other $200, their appearance to the eye of the most skilled will be precisely the same, as far as these adjustments go, and the difference can only be determined by testing the two for time. This may serve to explain why high and low priced watches differ so little, apparently. Usually, however, the higher priced Waltham watches have a much higher finish throughout, and are filled with jewels, often of costly stones, whereas the cheaper watches have fewer jewels. This makes a difference externally, but still the principal difference of price will be due to the finer adjustments above described. Watches possessing these finer adjustments should be treated with the greatest care, lest these delicate virtues should suddenly depart, leaving the watch one of the most common grade. The repairs of such watches should be entrusted to only the most experienced, and even then fears may be justly entertained of the slight bending of the hair-spring or of a trifling displacement of some of the weights of the balance, either of which might result in serious consequences.

As regards these delicate though essential qualities for correct time-keeping, the Waltham Watch Company has learned just what they are, and each watch is constructed with a view to securing them, as far as practicable. For instance, the hair-spring should vary in thickness when coiled in the volute form, and the balance rim should be formed of two metals cut open on opposite sides, and weighed in a manner indicated by experience. These requirements are approximated to as closely as possible in the manufacture of the parts of all the Company's watches, by means of which the most common Waltham watch is made a reliable timer. In this largely consists the superiority of our American watches, for time, over those of our European neighbors, which latter are likely to turn out good, bad or indifferent, for the want of that system of adaptation of the essential parts for securing their objects. In this the European experts have been much surprised at the great advances made in American watch-making, illustrating the fact that watch-making, instead of being merely an art, as regarded for ages to be in other countries, it has also for its basis a true science—a science which can find no substitute in mere hand-craft. Indeed, to enable the reader to fully appreciate the high character of the scientific basis upon which the fine time-keeping qualities of the Waltham watch are founded, it will be necessary to go further into the details of that science which the American watch thus personifies.

The first great thing to seek in any perfect time-keeper is isochronism of the escapement. This means precisely equal times of vibration of the oscillating part of the escapement, whether that be the pendulum of the clock, or balance of the chronometer or watch. Mathematical investigations show that a given pendulum cannot possibly vibrate through wide arcs in the same time that it does through small ones, unless the ball of the pendulum be constrained to move in a cycloidal arc. As the practical difficulties for securing this are considered by clock makers insurmountable, the arc is unavailable in practice; and hence the pendulum, which varies its arc in response to every imperfection of the train of wheel-work, and with the varying consistence of the oil with which the parts are lubricated, the latter at once fails to answer the scientific requirements. But when a body is supported and made to vibrate by the action of a spring alone, the mathematical laws of elasticity of springs, and of the resistance of masses, show that such vibrations are perfectly isochronous, whatever the arc of vibration.

By making this the vibrating part of the escapement of a time-piece, the latter will be at once theoretically perfect. Thus we see that the chronometer and watch, which have in the hair-spring and balance such a vibrating device, are, inherently, time-pieces of a higher order than the astronomical clock. While the former remains perfect with almost any train of wheelwork, giving impulses no matter how irregular, the latter is only perfected by an absolutely correct mechanism and lubricants, by which equal arcs of vibration must be secured.

With thus a theoretical correct escapement to start with, the next problem was how to realize it in practice. The volute hair-spring, or one whose coil is flat instead of helicoidal, is found preferable for watches for considerations of compactness, though the helicoidal form is usually employed in chronometers. But the former is found not to be practically quite isochronous when the wire of the spring is of perfectly uniform size. But by making the spring of a wire which varies its thickness gradually from beginning to end, isochronism is still retained. In all American watches we find hair-springs possessing this delicate though very essential quality, and to this is largely due the great excellence of all grades of these watches.

The American watch is thus not only perfected in time, but greatly simplified in construction. For instance, where the escapement is not isochronous, and must preserve equality of arc of vibration, the barrel and fusee is necessary, This is found in all of the best English watches, by which the varying tension of the main-spring is equalized, and made thus to impart equal impulses to the escapement. This adds many pieces to the watch, and increases greatly the danger of derangement. Such expensive equalizing, is entirely unnecessary in the American watches with their perfect escapements, and hence, watches of the highest order are rendered available at a small cost.

Although perfection of the train of wheel-work in watches possessing isochronous escapements is of secondary moment, yet this, in the Waltham watches, is made with none the less care. The gearing is all cut with epicycloidal teeth, which is the best form for watch-work. The pinions are formed from Stubbs' steel wire, the teeth cut with burr cutters and polished on an accurately shaped *form*. Each tooth is cut four times over; three cutters being used, two for the preliminary, and one for the very light finishing cut. Both the cutters and the polishing *form* are made truly epicycloidal by means of an epicycloidal machine. This machine shapes a *master cutter*, by which the working cutters are made. The polishing cutter machine is fitted with an attachment supporting a tool of the required shape, by which the polishing-form is often reshaped as it wears away. This polishing of the teeth is performed on an automatic machine, which, with perfect regularity, gives each tooth precisely the same strokes. With all this precaution the pinions cannot escape a near approach to absolute perfection. The brass wheels are cut with a single point fly-cutter, but it is formed with no less care than the pinion-cutters are by aid of the epicycloidal machine.

Finally, we may observe that the watches manufactured by the American Watch Company, at Waltham, Mass., are made as nearly perfect as possible, not only with a view to complying with the demands of mathematical research for perfect time-keeping, but by bestowing upon all the minor details that careful attention which insures to the finished watch that reliable character and durability so much needed in this age when the world lives and travels by machinery.

THE "CENTURY CLOCK."

In a prominent position in the Kansas building, Centennial Grounds, stands an invention bearing the title of this article, and which is the invention and handiwork of Mr. J. W. Hile, of Waterville, Marshall Co., Kansas. The peculiarity of this recently invented horological novelty is that it requires winding but once in 100 years. The means for accomplishing so long-continued a run without excessively heavy weights and long winding, are novel desires for reducing to a minimum the friction of the pendulum and escapement. Happily the inventor has effected this, not only with very simple and inexpensive means, but by much cheaper and less complicated apparatus than that ordinarily employed in the manufacture of time-pieces.

The pendulum is a heavy horizontal brass ring, suspended by a thin compound bow of brass and steel, and so split as to be susceptible to variations of temperature, and remain perfectly isochronous. The bow and wheel are hung by a torsion spring of steel, and make about 2½ revolutions at each torsional vibration, occupying one minute of time. As this bow constantly rotates in a fixed spot, there is little or no atmospheric friction; and that little is produced merely by the suspending compound bow.

The weight and density of the atmosphere are constantly changing, as shown by the barometer. This causes an ever varying weight of all pendulums, and an ever varying resistance to motion from this cause, as also from the constantly changing density of the atmospheric medium. This pendulum having the *minimum* of atmospheric resistance from the mode of its construction and operation, has consequently the *minimum* of variation from these disturbing causes. In addition, it can be accurately adjusted to changes of temperature, which is another cause of variation, at much less cost than any other. These considerations are of the highest interest to the scientific horologist.

At each torsional vibration the escapement receives its impulse; differing in this from all others yet constructed, in that the impulse is received *on one side only*.

This escapement may be made to beat any interval of time, from one second to two and a half minutes. Quarter minute beats are found very convenient for regulators, as by them the observer can detect the slightest variation in a watch at each beat of the clock.

The beats are instantaneous, and between them the train remains firmly locked and the pendulum rotates entirely independent of the train; thus obviating the variations caused by gum or the irregularity of the train. The momentum of the pendulum weight imparted by the scapewheel, through the medium of the torsion spring, locks and unlocks the scapewheel. By using a watch hair-spring for torsion-spring, a clock can be made that will beat minutes, and run one year, with a watch main-spring, by once winding. A tower clock would operate successfully with an eight-day clock main-spring for a torsion-spring, with less power than is ordinarily used, or more power be used if desired. For tower clocks this improvement should prove of remarkable value. The claims of the inventor are that, while this clock requires winding but once in one-hundred years, and keeps the most accurate time,—telling the month of the year—the day of the month—the day of the week—the hour of the day—and the minute of the hour, it does this with from ten to one hundred times less power than is required with any other clock escapement ever invented.

This result, as he states, is accomplished from the fact:—*First*, That it requires less power than one-third the usual power to operate the pendulum and escapement; *Second*, The power is not exhausted so rapidly; *Third*, A clock with this escapement is less complicated and consequently has less friction.

This "Century Clock" is the only one yet made; and has been finished and running about six weeks. The new escapement is not yet on the market, but is exhibited with twofold intention (1) of demonstrating that clocks may be greatly improved as regards their accuracy of action, and the amount of power required to drive them, and (2) of making arrangements with suitable parties for the general introduction into the market, of clocks on this principle, to run from eight days to one year, as they can be manufactured much cheaper than common clocks, by means of requiring less machinery; and should for this and other reasons supersede the ordinary styles.

THE

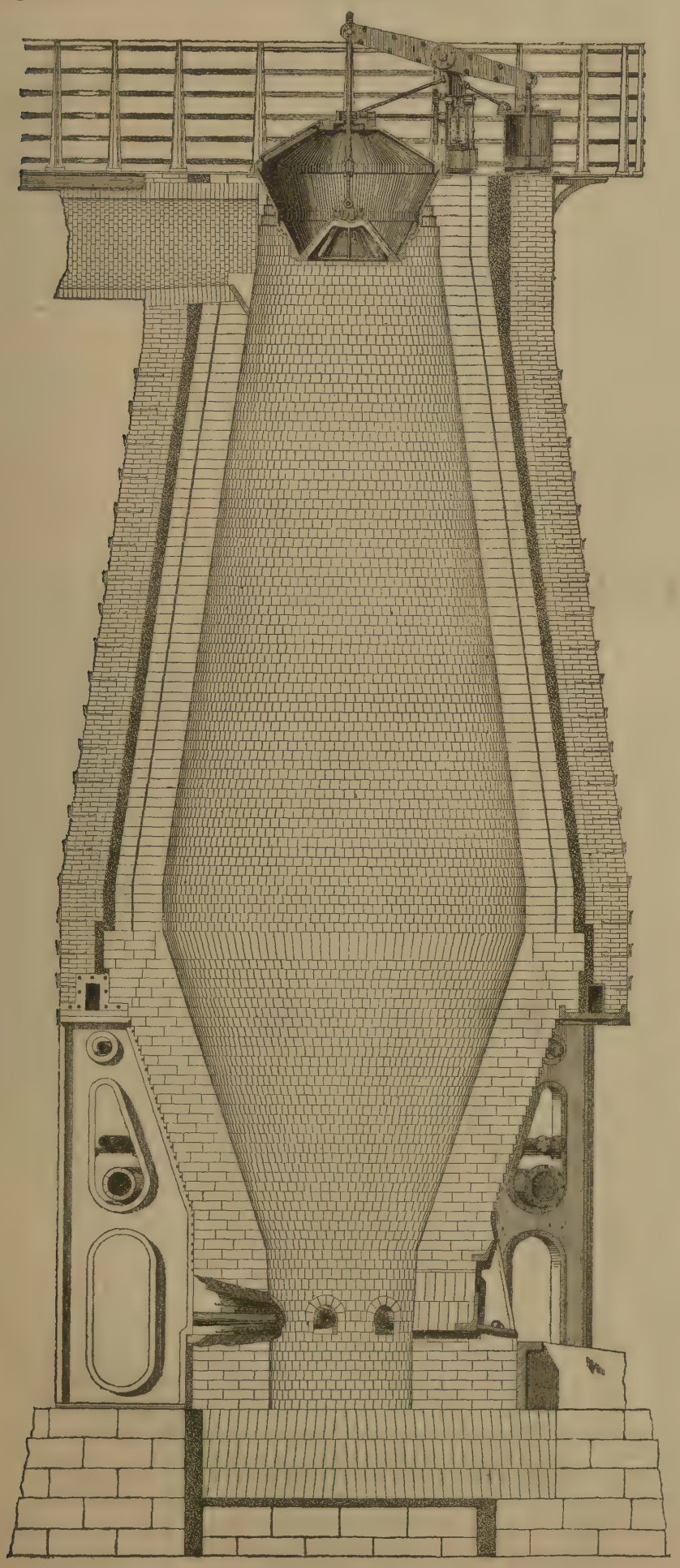
POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA SEPTEMBER 9, 1876 NO. 10.

IMPROVED BLAST-FURNACE CONSTRUCTION.

In the days when charcoal only was used for smelting iron, it was considered essential to enclose a small "melting pot" with immense masonry walls, and the furnaces were generally placed beside a stream, so that it might give power to move the water-wheel, which in turn operated the pistons in wooden blowing tubs, while the ore and product were carried over mountainous roads for miles.



With the introduction of anthracite, bituminous and coke furnaces, the cheapening of iron and the increased demand, furnaces were moved to locations convenient for receiving the raw material and shipping the product. The number of tuyeres were increased and iron columns were used in place of a series of arches. Smaller masonry walls were used, secured by an iron casing or a series of bands. The waste gases were no longer allowed to escape freely into the air, but were diverted under hot blast stoves and boilers, by means of the till and hopper. And steam engines were employed to furnish blast in greater quantity and intensity.

We illustrate a modern furnace of improved design, only regretting that we cannot place beside it a cut of a charcoal furnace of a hundred years ago, with its massive square walls and single tuyere arch. This furnace was designed for the North Jersey Iron Company, by Messrs. P. L. Weimer, of Lebanon, Pennsylvania, and John Birkinbine, of Philadelphia, and is the result of careful study of these engineers to erect a blast furnace, with the least expenditure of material and money, compatible with integrity and permanence of structure.

All of the walls are made as light as possible, and every provision is made for keeping the furnace cool about the bosh walls and crucible.

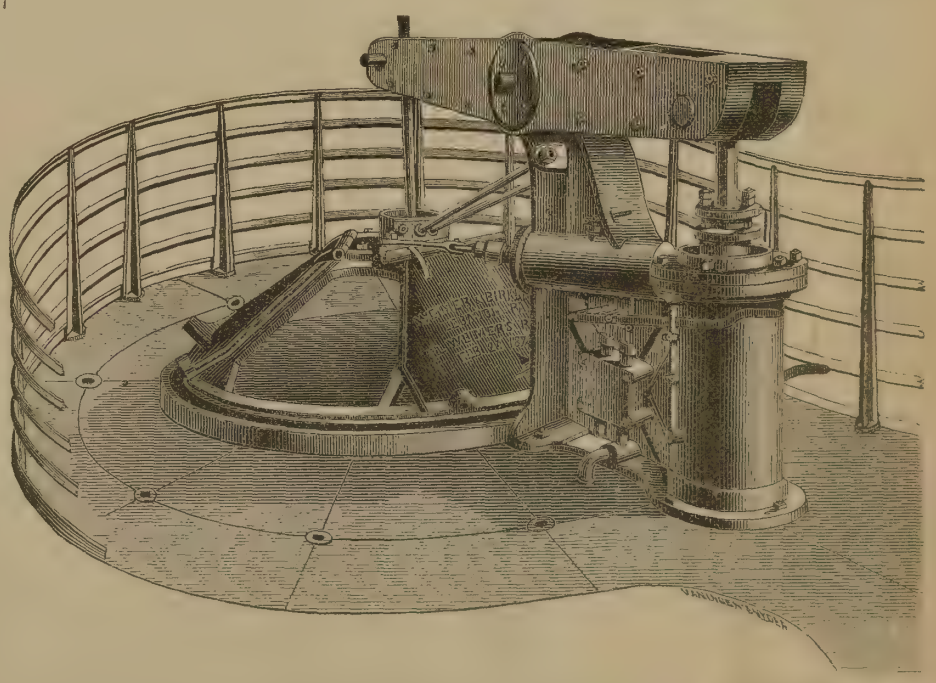
Instead of the ordinary masonry pillars or iron columns, housings are used, which extend up to and support a hollow mantel just below the "bosh" or greatest diameter. The hollow mantel is so formed as to be of great strength and at the same time keep the bosh cool. The heavy iron housings which support the mantel and superincumbent masonry, are cast so as to support also the bosh walls, crucible walls, water, blast and spray pipes; the spaces between them giving ready access to tuyeres, etc. Slots are cast in the faces next to the walls of the housings, to accommodate T heads on square iron rods, so as to bind the bosh walls with a minimum amount of iron; the bands having to extend in this case only from one housing to another instead of around the stack, can be much lighter, and expose more of the masonry to the cooling effect of exposure. The spray pipe just below the mantel can also be used to cool the bosh walls.

An iron casing encloses the crucible walls, leaving space for sand, through which water is permitted to percolate for cooling effect.

The walls above the mantle follow the general slope of the in-walls, and are secured by iron bands varying in size and fastened by double clevices. The top of the stack is surrounded with an iron casing having openings for the "down takes" to the hot blasts and boilers.

The liberal distribution of iron ores and coals throughout our country has stimulated the erection of iron furnaces, until our production is of such magnitude that only those which are economically constructed, managed with care, and advantageously located, can be expected to be good investments. Every dollar saved in proper construction tends to cheapen the cost of producing iron by reducing the interest on invested capital.

The tunnel-head is fitted with the ordinary bell and hopper, covered by Mr. Weimer's patent furnace charger, illustrated below. This consists of an inverted cone placed over the hopper, in which there are openings through which the ore, flux and



fuel are charged. These openings (there are three in the apparatus as illustrated) are closed by sliding doors secured by hinges to a revolving ring on top of the cone. The hinges are placed as a precaution against accident from explosions of gases while the doors are closed.

Near the tunnel-head is secured a casting, acting as a fulcrum to a wrought-iron beam, and enclosing two cylinders, one vertical and one horizontal. The cylinders are

fitted with the necessary valve-chests, valves, pistons, etc., and can be arranged to be operated by steam, hydraulic, or pneumatic power. Upon one end of the beam the bell is hung, and the piston rod of the vertical engine engages with the other end. A weight box in the beam permits of the proper balancing of it, and the height of the bell can be regulated by a screw and nut on the rods supporting it.

The piston rod of the horizontal cylinder engages with a connected rod secured to the revolving ring carrying the sliding doors.

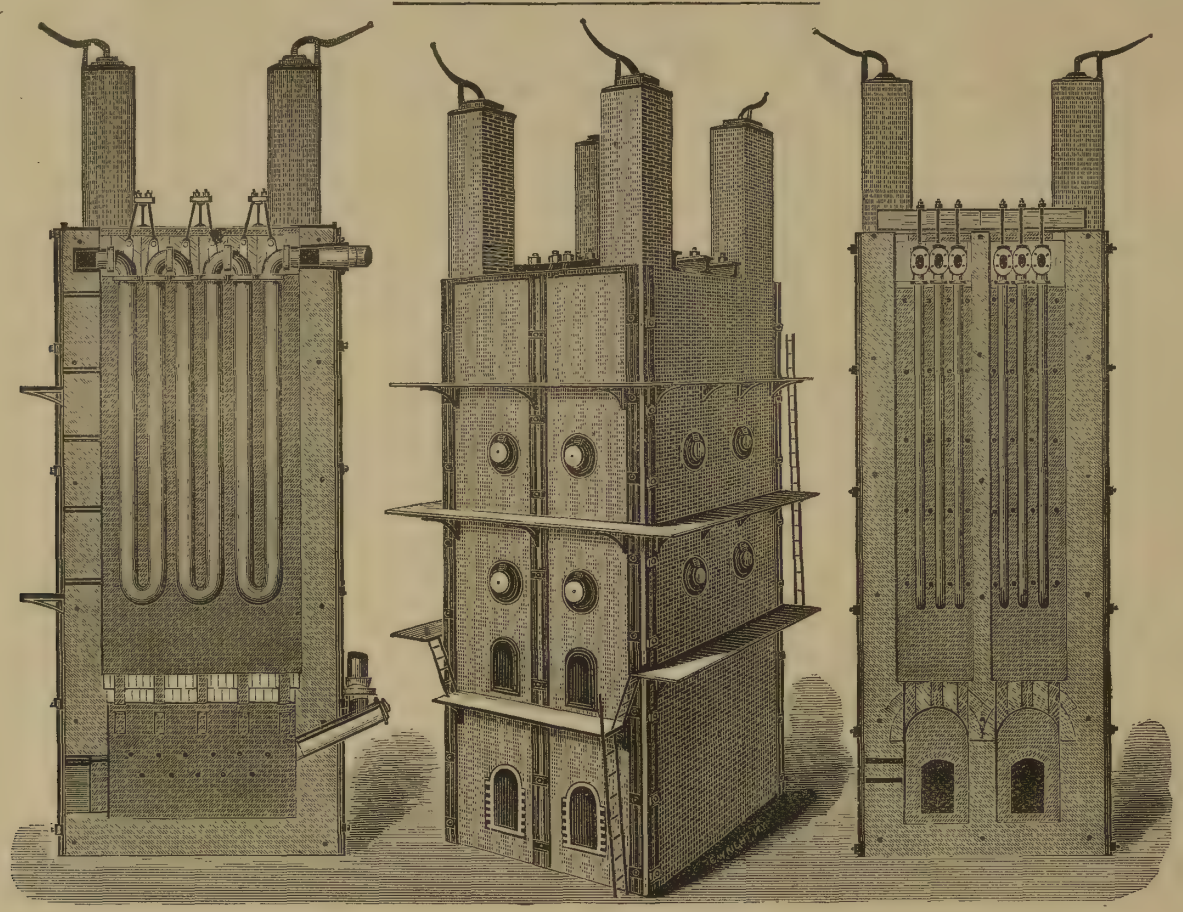
Ordinarily, in dropping a charge with the bell and hopper, a large volume of gas escapes, not only from the throat of the furnace, but also from the down takes, hot blast stoves and boilers, necessarily occasioning intermittent temperature. To obviate this trouble and secure the regular operation of the furnace, this charging apparatus is designed. Its operation is as follows :

The furnace being in operation and the bell closed against the hopper (both of which are turned off to make a joint) the doors are open, and the charges of ore, flux and fuel are dumped into the hopper, but cannot reach the furnace on account of the bell being closed

When the charge is ready to be dropped, steam is admitted into the horizontal cylinder, and the movement of its piston closes the sliding doors.

Steam is then admitted into the vertical cylinder and the bell is lowered, the charge passing into the furnace ; after which the bell is raised and doors opened by reverse action in the respective cylinders. The entire apparatus is under the absolute control of the attendant, and the operation of each cylinder is independent of the other, and is regulated by the levers shown.

It is obvious that, in dropping the charge, the only gas which escapes is the little which could be contained in the space between the bell and cone of the charger ; the flow to the boilers and hot blast stoves is therefore uniform, and the operation of the furnace is as a consequence under more direct control. In many furnaces the gases from the tunnel-head are not sufficient to properly heat the blast and generate the steam for driving the engine, and additional firing is required. The amount of gas saved by this charger would materially lessen the amount of fuel required for this purpose.



SUSPENDED PIPE HOT BLAST STOVE.

The Weimer Machine Works of Lebanon, Pa., display in Machinery Hall, B-69 and 70, a model of their suspended pipe hot blast stove, lately introduced to the American iron trade. The illustration gives a fair view of its interior as well as exterior appearance, and to the eye of the intelligent and practical furnace man needs but little description.

The increasing temperature required by the modern blast furnace practice has so far shortened the life of the ordinary standing pipe stove, that a new departure in this line became necessary. One of the principal objections to the standing pipe stove is the tendency of the pipe to warp and topple over long before its vitality is otherwise impaired.

Another and more serious objection to the old stove is the removal and replacement of injured pipe, generally causing a delay of a few days. Mr. Weimer endeavors to meet both these objections in his new oven ; the first by suspending the pipe from the roof ; and the second, by having the joints of the pipe *outside* of the stove, and so arranged that a defective pipe can be replaced in less than one hour's time, not even necessitating the cooling down of the stove. In addition to these advantages Mr. Weimer divides his upper pipe chamber into two parts with a central wall ; the lower or combustion chamber being similarly divided, the flow of gas to either chamber, and consequently the heat, is under the control of the operator.

PREVENTING INTENSE RADIATION FROM BOILERS.

A contemporary has an article entitled "Subaqueous Ovens," and referring, in strong terms, to the intense and weakening heat of the fire-rooms in ocean steamships. Alluding to the employment of felting and lagging, as a means of preventing radiation, it speaks of the omission of such protection from the boiler fronts, on account of the necessity of exposing them for the purpose of cleaning tubes, etc. To prevent this intense radiation, our cotemporary proposes a movable double plate iron shield, with a non-conducting material in the intervening space, and the whole sliding out of the way when desired.

We would propose for the same purpose a very thick curtain of asbestos cloth, which would be cheaper and more impervious to heat, and could readily be rolled up or drawn aside when desired.

Or, by a very slight alteration in the end casting or front piece, the whole surface, save a slight space around the latch and hinges of the smoke-box door, could be heavily coated with asbestos plaster—with an air space, if desired—and would offer no hindrance to ready access for flue cleaning. A slight economy in fuel should result, as well as comfort to the firemen.

But what is most needed is the general introduction of reliable "mechanical stokers." G.

OUR INCREASE IN ADVERTISING RATES.—We have been so frequently asked the reason for our repeated increase in advertising rates, that we take this mode of replying. The circulation of our journal having increased, our advertising columns are worth more than formerly ; and we shall continue to raise our rates almost in the same proportion with our circulation ; endeavoring at all times to give our advertisers rather more than their money's worth.

CONCERNING SPONTANEOUS COMBUSTION.

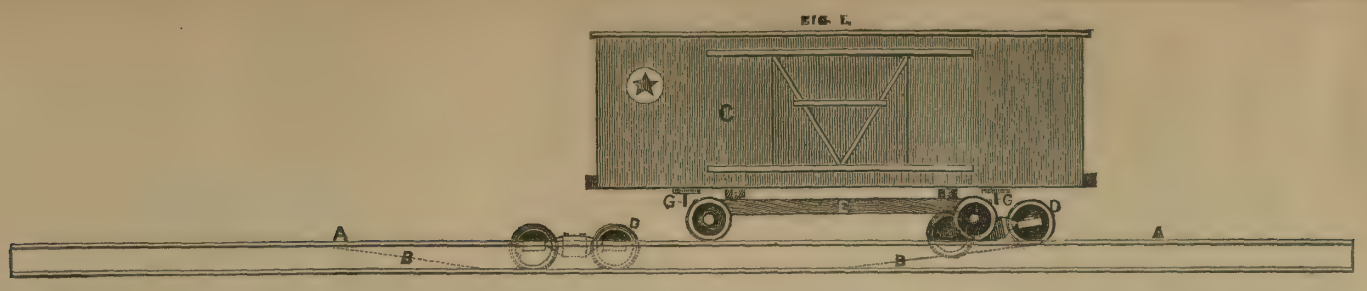
V.

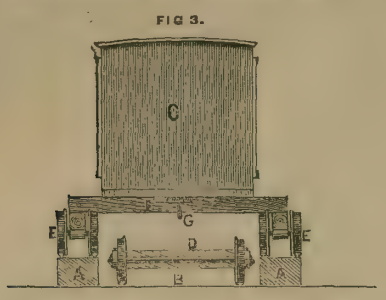
Allusion was made in the last issue of the "REVIEW," in the communication on the above subject* to the fact that silk was liable to spontaneous ignition, This allusion was made in the following words: "It seems to be well established that black-dyed silk is liable to a similar alteration (*i. e.* spontaneous ignition) although its real cause has not yet been satisfactorily ascertained." Since the appearance of the contribution in question, a fact has come to the knowledge of the writer, that in all probability will throw some light on the subject, as will be perceived from the item herewith reproduced from *Harper's Annual Record of Science and Industry*, for 1875: viz:—

The debasement of silks by foreign admixture, if we may infer from the comments of journals devoted to textile interests, has of late reached such a height as to promise shortly to rival that of a class of cotton goods which have added largely to the notoriety, if not to the fame, of one of the manufacturing centres of England. A writer to one of the French journals shows that the weighting of black silks—which began with the modest aim of making up for the loss sustained in ungumming—is now carried to the extent of 100, 200, and 300 per cent. This increase of weight is effected by treatment with salts of iron and astringents, salts of tin and cyanides. The bulk is augmented proportionably to the weight. The same writer points out very clearly the evils attending this excessive adulteration. The chemical and physical properties of the silk thus treated are materially modified. What is sold as silk is, in reality, a mere agglomeration of heterogeneous matters devoid of cohesion, held together temporarily by a small portion of silk. The strength and elasticity of the fibre are likewise reduced. From being in its natural state one of the most stable of substances, and but slightly combustible, in its adulterated state it burns like tinder if touched by a flame. It is likewise affirmed to be liable to undergo spontaneous decomposition, and to absorb gases with the evolution of heat which sometimes lead to actual combustion. The adulterated silk when burning scarcely gives off the characteristic odor of animal matter.

W.

*This Journal, ii, 65.





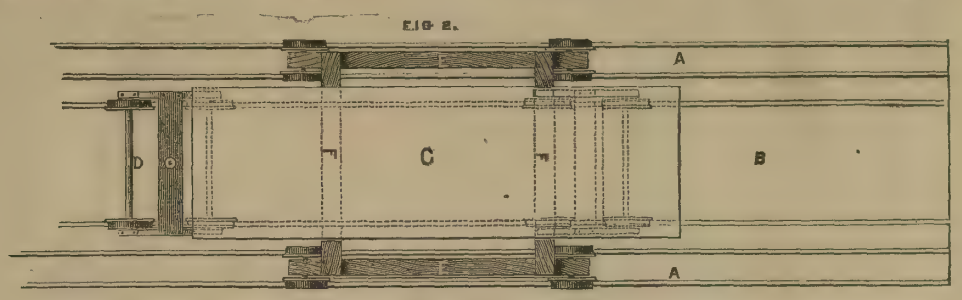


Fig. 1 is a side view of the depressed railway, and trucks on level outside tracks supporting a car body.

Fig. 2 is a top, and Fig. 3 an end view.

(A) represents level outside tracks along the depressed main track.

(B) the pit, with incline at either end.

(C) the car body, from which the trucks (D) are taken.

(D) trucks that have been removed from the car.

(E) the side trucks on outside tracks.

(F) the cross-bars for carrying the car body.

(G) the king-bolt on the car body.

RAMSEY'S CAR-TRUCK SHIFTING APPARATUS.

(CANADIAN DEPARTMENT, MACHINERY HALL.)

This is a simple and effective arrangement for changing car-trucks quickly and with very light expense, either for labor or for the apparatus. It consists merely of a switch having a depression or pit about 18 inches deep, with gentle inclines at each end, and on each side of which is a narrow track on the general level, and bearing strong trucks which carry beams thrust under the car for the purpose of supporting the weight of the car while the trucks to be removed are run down the incline, and replaced by others. The device is ridiculously simple, and yet we must admit that the use of the steam hoist or of jack-screws is as ridiculously costly, and in the latter instance hurtful by breaking the backs of cars. The same system may be used in changing gauges, and may prove of great value in assisting the early and general solution of the narrow-gauge question. Railroad men need no detailed description of the method and of its manifold advantages. The cuts illustrate it very clearly. G.

THE SKINNER PORTABLE ENGINE.

(K 78, AGRICULTURAL HALL.)

This engine has some very meritorious features. As will be seen from the cuts, the boiler is horizontal, with return-flues. It is entirely of wrought iron, steam-riveted; the heads being of heavy flange-iron; the tubes lap welded. In the cut, Fig. 2, the interior view of boiler and fire-box are given. B is a fire-brick lining, extending throughout the whole length of the casing; P is a sliding bridge-wall, giving a variable grate surface, and having an air space, A, in which air enters, as shown by the arrows, keeping the wall cool and promoting good combustion. The adjustment of the bridge-wall allows of the use of fuel of any length, from 18 inches to 4 feet. D is a depression for preventing coals from dropping out when the door is opened. The heater is shown in sectional view above the boiler. The water line is above the heating surface. By removing a plate in front, the boiler and flues are accessible for cleaning. (See Fig. 3.)

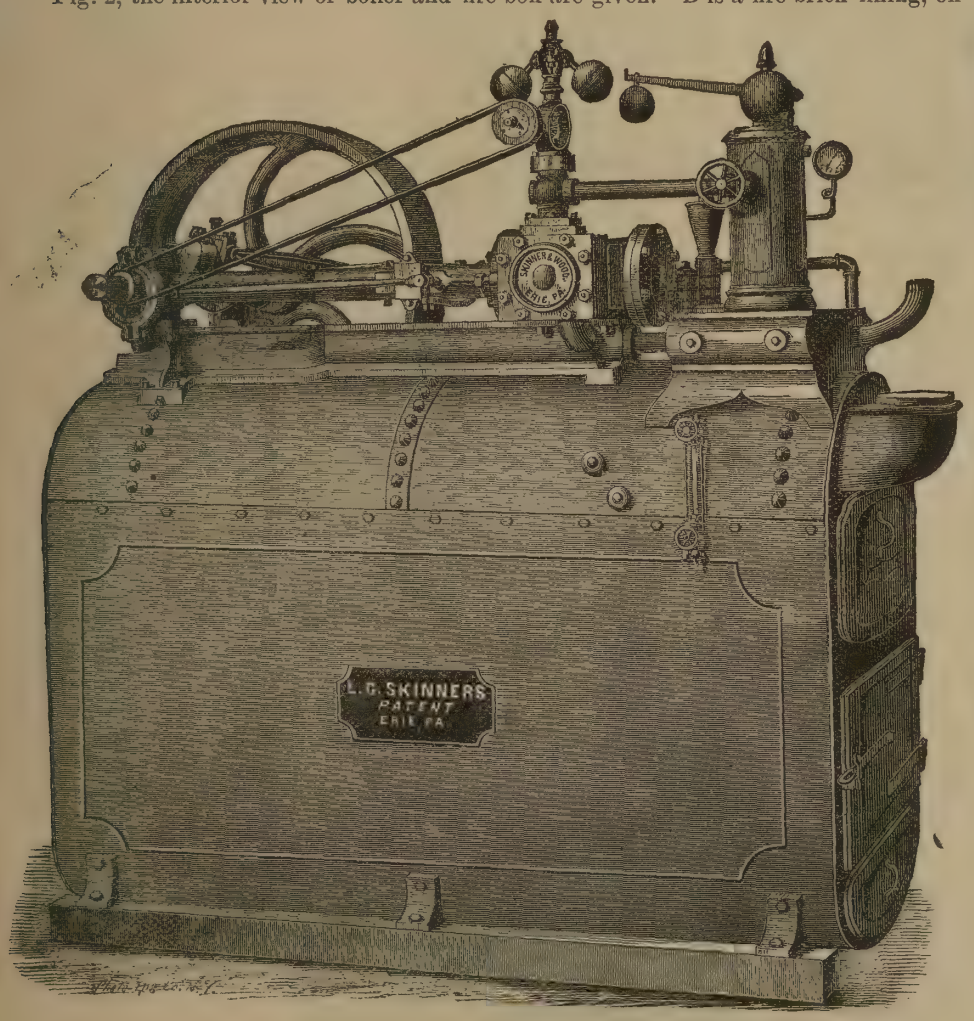


Fig. 1.

The engine has the cylinder head, guides, and pillow-block cast in one piece, in line with the center of the cylinder. The bed is formed to prevent drip from reaching the boiler. The valve is of the plain D type, cutting off at ⅞ stroke, and its rod having a rectangular bearing outside of steam chest; the eccentric rod is attached to the valve rod between the bearings and the steam-chest. The piston has metallic ring packing. The pump, which is driven by the crosshead, has interchangeable brass valves and seats. The engine is provided with a Skinner stop-motion governor to prevent "running away;" and also has a combined check, stop and relief valve, obviating any trouble caused by neglecting to open the stop valve between the pump and boiler.

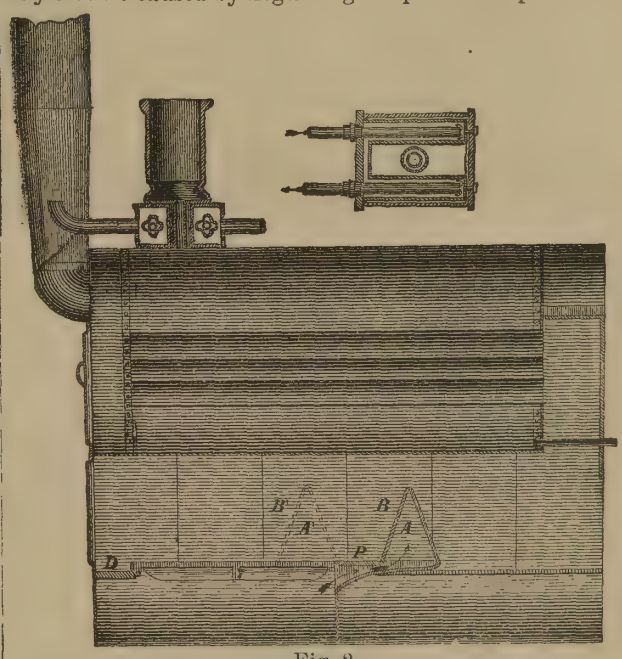


Fig. 2.

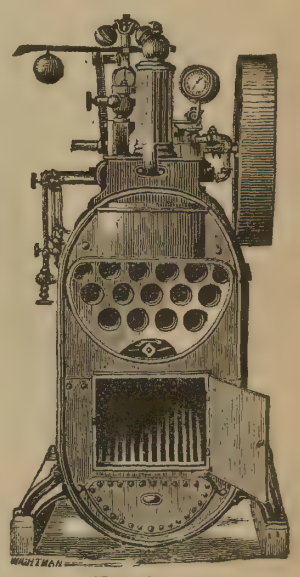


Fig. 3.

The boiler of the 5-horse size has 6 square feet of grate surface, 75 square feet of heating surface; its rating being based upon 15 square feet of heating surface per E.H.P. The cylinder of the 5-horse size has 5½″ bore, 8″ stroke, producing its guaranteed E.H.P. by 160 revolutions under 60 lbs. of steam. The fly-wheels are quite heavy; all bearings large.

The makers claim to give the largest engine per rated horse power that is in the market.

One especially commendable point, to which we take special pleasure in calling attention, is that each boiler is tested to 180 lbs. cold water pressure, and is inspected and insured in the Hartford Boiler Insurance Co.; the policy for the insurance being sent to the purchaser. G.

THE WARDWELL VALVELESS ENGINE.—In our article on this engine in our last issue, an accident occurring in the absence of the writer and of his manuscript, compelled the omission of some of the data concerning the indicator diagrams. The pipe-pressure was 55 lbs.; number of revolutions, 100; giving a piston speed of 266 feet per minute.

In a few of the copies containing the article, the sentence referring to the Robertson (English or Russian) valveless engines, was misplaced, so as to state, after the mention of the Wardwell Oscillating Engine, "There being in these last, two steam and two exhaust passages, there is at each end of the stroke an exhaust passage to be filled ineffectively with live steam."

Those having copies with this misplacement, will please so mark the sentence quoted as to make it follow the preceding paragraph. G.

THE FERRIS & MILES' EXHIBIT AT THE CENTENNIAL.

Fig. 1.

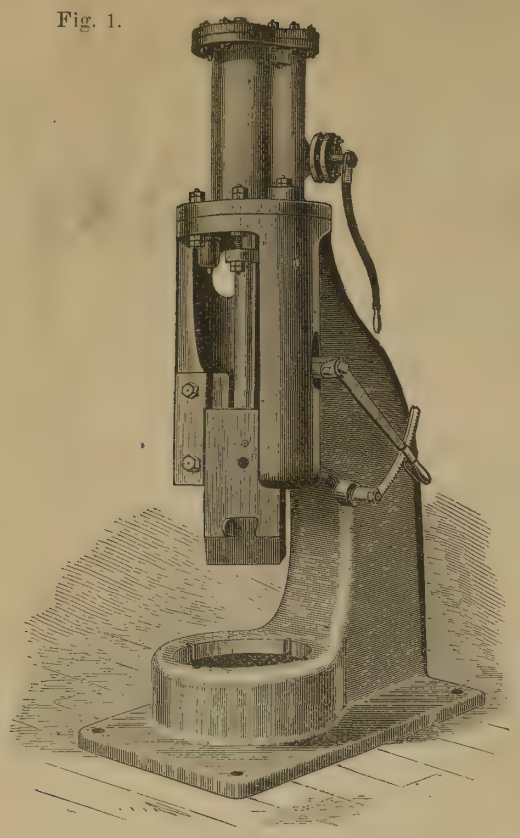


Fig. 2.

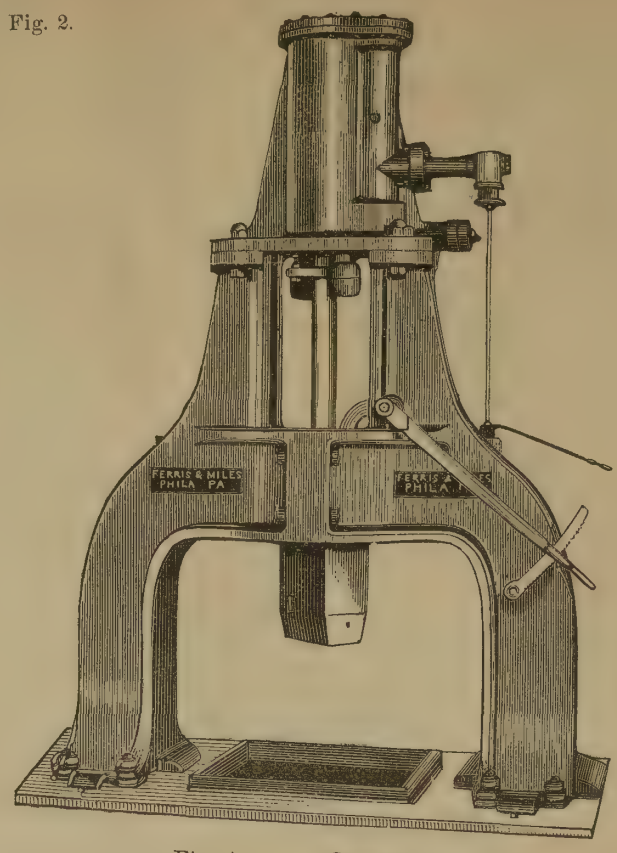


Fig. 3.

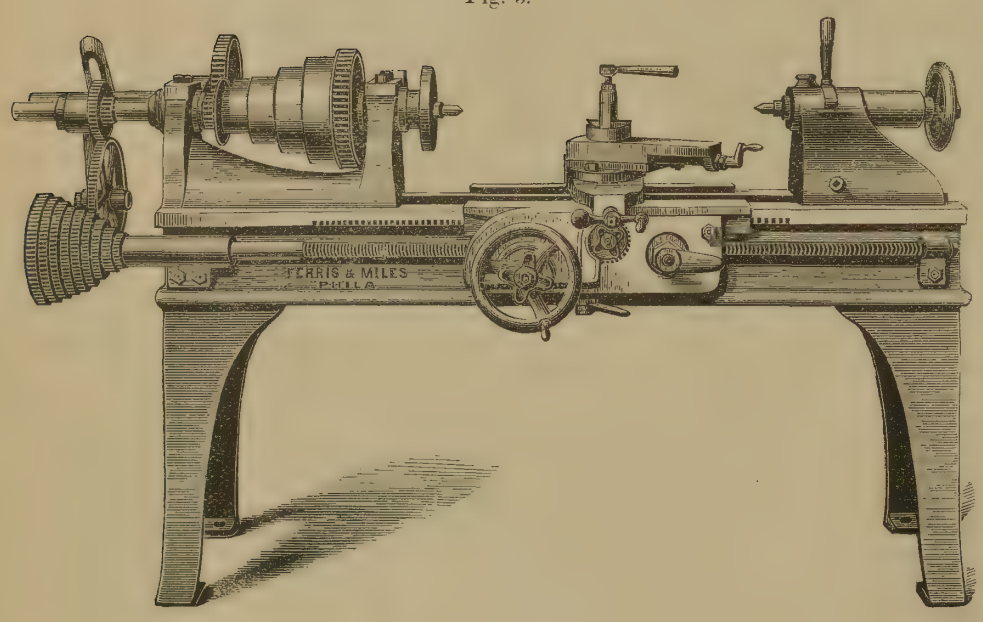


Fig. 4.

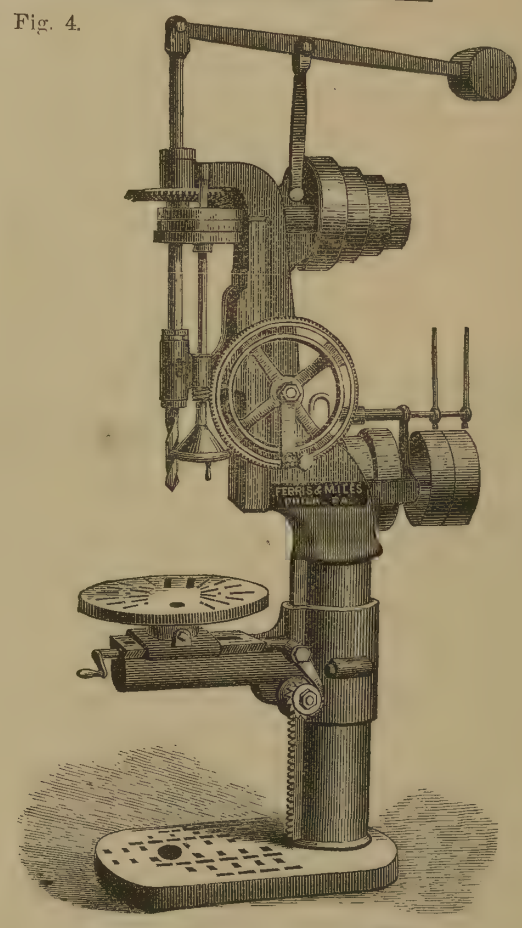


Fig. 5.

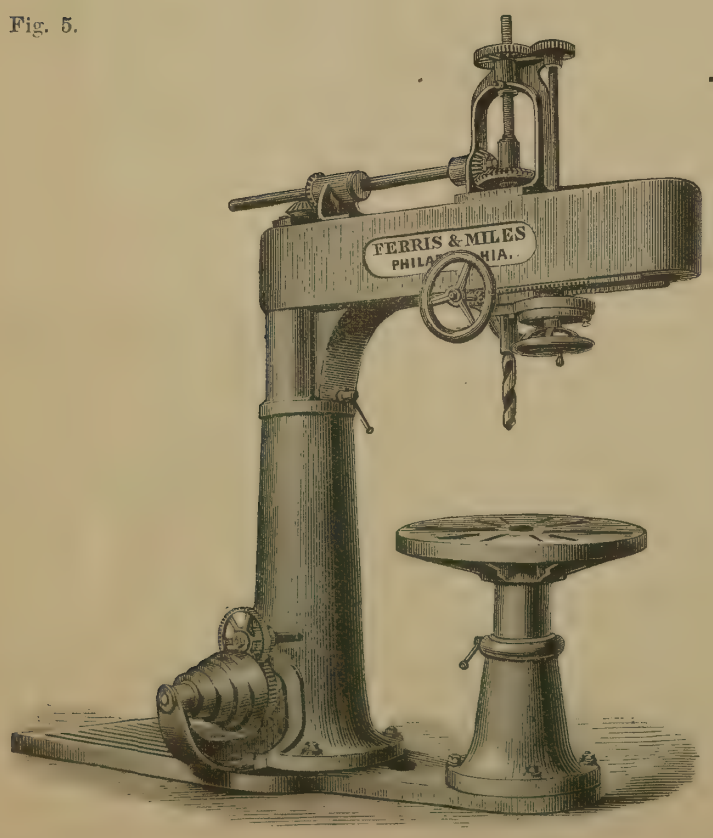


Fig. 6.

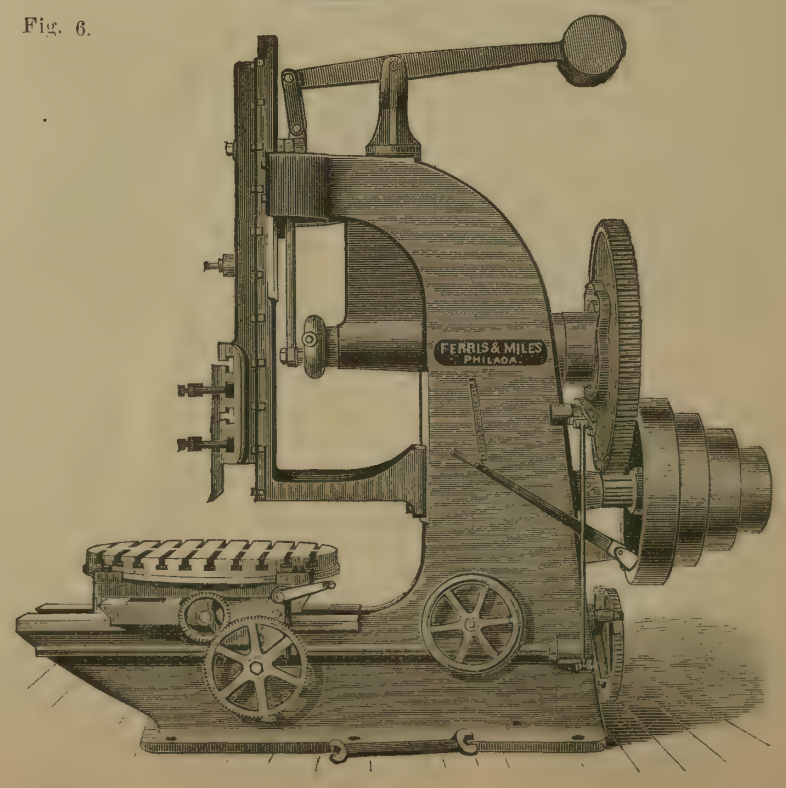


Fig. 7.

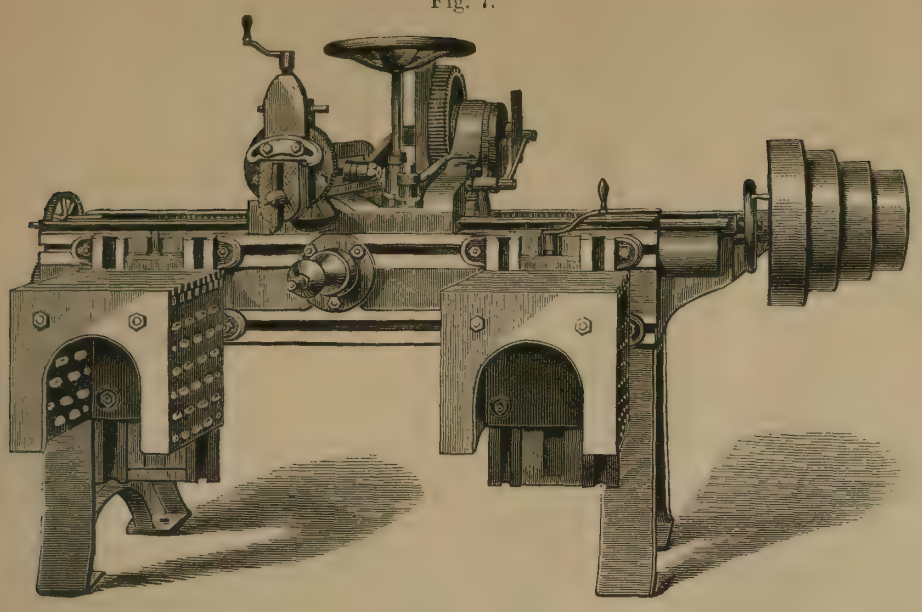


Fig. 8.

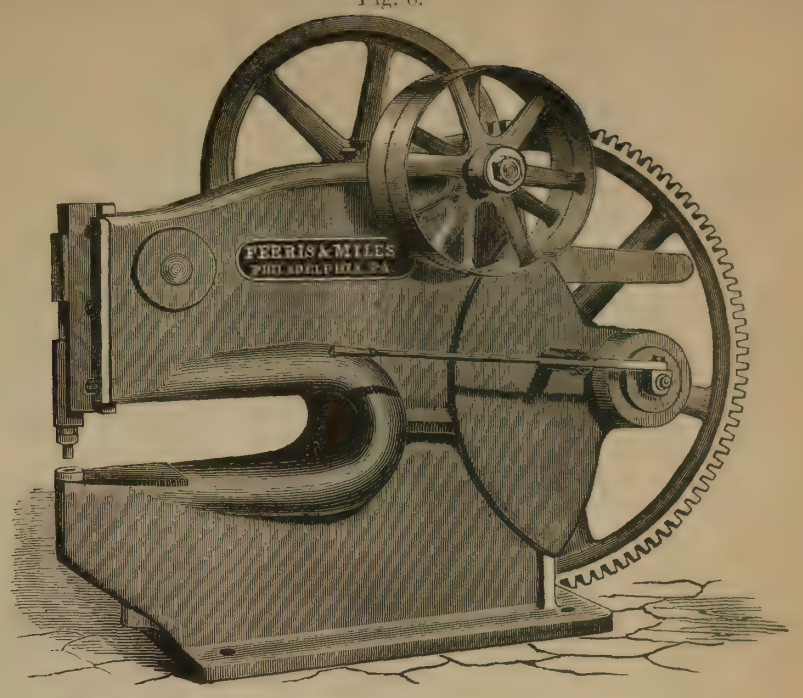
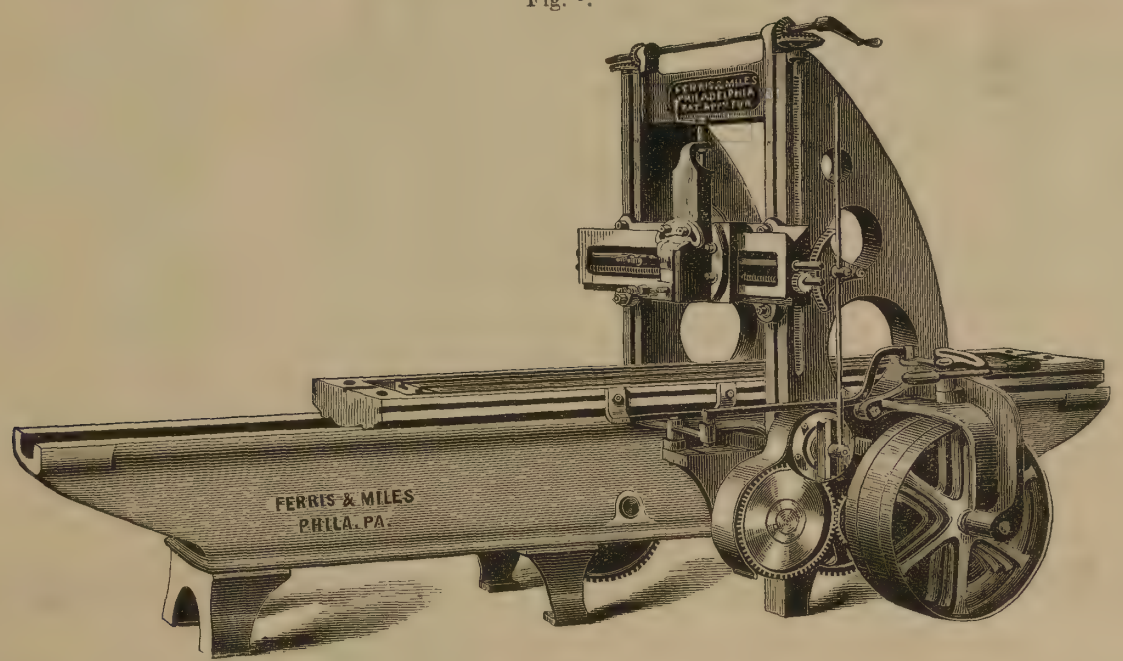


Fig. 9.



THE FERRIS AND MILES' EXHIBIT AT THE CENTENNIAL.

Of the many fine and meritorious exhibits of machinists' tools and special machinery shown at the Exhibition, that of Messrs. Ferris and Miles, B, 31, South Aisle, possesses many points worthy of careful attention. Among the builders of steam hammers, this firm is probably the largest in the United States; and the two excellent specimens of their single (see Fig. 1) and double frame hammers (see Fig. 2), give evidence of good material and workmanship; and what is of equal importance, evidence of thoughtful design and careful study to produce a simple and effective tool. The ram and anvil in the two hammers shown, are set obliquely, so that the work may be placed either across or endwise of the die without coming in contact with the posts.

In the double-frame hammer, joining and securing the two sides of the frame together at the bottom of the guides, is an excellent feature. In cornering down forgings, a terrific side strain is frequently brought upon the guides, which never can be too strong, and in many cases if they were brought down some inches closer to the work, less destructive strain would be thrown upon the piston rods. The valves in these hammers are balanced piston-valves, operated by simple mechanism and changed in position by the handle lever; the other lever operating the throttle, places the hammer under complete control, both for thin and thick stock, and for giving light or heavy blows.

Among the exhibits of Ferris and Miles, are shown three or four lathes of more than ordinary merit, all being strong for their capacity, of exceptionally good design, and possessing some novel features worthy of special attention. The form of shears adopted is the flat top, with 60° angle under-cut for slide-rest gib, a form used by Wm. Sellers & Co., and the best English and European builders, I believe, yet it is one that I do not think can be justified by any kind of theoretical considerations which take all the requirements into account, nor by practice, when a lathe that has been long in service, is taken as an example. To attempt to guide a slide-rest by the back edge of a lathe-bed, when the propelling power is at the front, is comparable to the attempt to move a T-square along the edge of a drawing board by taking hold of the end of the blade--and it is only accomplished in the lathe by making the slide rest longer in proportion than the T-square stock. In this respect, Ferris and Miles have done better than the other builders in making their slide-rests longer, and thus helping the matter without overcoming it. Their slide-rests, with reverse motion, both back and forth and in and out cross-feeds, with all changes made at the rest, are good, and especially for a long lathe do these features prove serviceable. They make the lead-screw serve the double purpose of screw cutting and a trundling shaft for running the feed-motion; a featherway, planed along the screw, gives motion to a clutch, and that to either of two bevel-pinions from which the feed motions are driven. The lathes are fitted with compound-rests, and all sliding surfaces and screws are well protected from dirt and cuttings. The lead-screws in some of these lathes are reversible, that is, they are fitted so as to be changed end for end; a first-rate idea, as this will nearly double the life of the screws, if not help to a certain extent to maintain their accuracy.

The open nuts on the lead-screws are complete nuts when closed, and of rather better length than most makers employ. A special feature of the 16-inch lathe (see Fig. 3) is that employed for the change gears used in screw cutting. The nest of eight gears is carried on the lead-screw; into either of these the intermediate may be geared, and by changing the intermediate into either of the two gears on the main spindle, 16 different threads, ranging from 2 to 14, may be cut. Probably there is no other arrangement yet devised by which the changes for screw cutting can be so quickly done as by this, and the only question is whether we can afford to sacrifice the old time-honored step screw for the advantage it affords. Some would hesitate as much about doing away with the step screw to a lathe spindle, as a millwright would about dispensing with a step to a millstone or turbine wheel; and yet the necessity or utility of the device may be imaginary. One peculiarity noticeable about these lathes, when compared with those of New England make, is that the shears are left direct from the planer tool. While the makers have not attempted to correct the errors of the planer by the use of the straight edge and scraper, they have not added to the inaccuracies by the draw-file and emery. Whoever buys a lathe from this firm will get an out-and-out good tool; in fact the same may be said in regard to any other of their machines, of which their exhibit shows quite a variety. Though they occupy far less space than some of their neighbors, the collection shows quite a range of subjects, each possessing some special feature. Their upright *drilling machine* (see Fig. 4) has a convenient device for throwing in the power-feed. The device for moving the traveling head on the radial drill (Fig. 5) moves with the head, and is not at the end of the boom as in some other machines. Their slotting (Fig. 6) and shaping machines (Fig. 7) have the Whitworth quick-return motions. Their punching machine (Fig. 8) for boiler and bridge work, is specially arranged for working close into angles—and each and all the exhibits have some features about them which it will be well for those interested in that specialty to examine.

J. E. S.

Department of Mechanical Engineering.
Cornell University, Aug. 30, 1876.

A MEETING OF INVENTORS of the United States has been called, to meet at the Hall of the Franklin Institute on September 8th, to take into consideration the improvement of our patent system and to take measures to secure a unification of the patent systems of various countries.

ANNUAL REPORT OF THE HARTFORD STEAM-BOILER INSPECTION AND INSURANCE COMPANY, 1875.

COMPLETING THE FIRST DECADE.

We reproduce here a large portion of the contents of this interesting and valuable report, and advise that all steam users send for the pamphlet, which, like its predecessors, is a valuable contribution to the literature of the steam boiler (so called). If, by the reproduction in our columns of the record of this sad and expensive experience of carelessness and neglect, we can aid in teaching lessons of caution, we shall be well satisfied. G.

"The extent of the Company's business will be better understood when I say that since its organization its inspectors have made 150,042 separate examinations. This includes internal and external inspections. These examinations have developed 16,764 dangerous defects. * * * During this time 788 boilers have been condemned, as worn out and unsafe to run. There have been in the past ten years a great many boiler explosions, attended with fearful consequences. * * * The record kept in this office shows that there have been 848 explosions in the past ten years in this country, by which 1,768 persons have been killed, and 1,904 more or less wounded. Of the boilers under the care of this Company during the past ten years, 18 have exploded, doing damage ranging in each case from $1,800 to $5,000. * * * * By these explosions fifteen persons were killed. Most of these explosions can be easily accounted for. In the iron works, in one case, the boiler was fed by a plunger pump, driven by the engine. The packing in the piston being disarranged, the engine was stopped to readjust it. It required more time than was expected, and the fires being kept up in the boiler, the water became low and the fire sheets were burned. The boiler exploded directly after starting up the engine. In four other cases of explosions in iron works the boilers were fired by the waste gases from the furnace. The hangings of the boilers gave way, throwing the weight on to other supports, which were not sufficient to sustain them, and the boilers were broken in the girth seams. There was formerly a great error in the hanging of iron works boilers. They were supported at three points, viz., at the ends and in the middle. This practice was followed with boilers fifty feet long. It will be seen that boilers hung in this way, and fired by a stream of gas licking their entire length, will be expanded at the bottom. The effect of this will be to curve the ends up, and throw the whole weight on to the center support. Boilers hung over furnaces fed by gas should have a support once in ten feet at least. It cost us some $10,000 to find this fact out. There are some expensive hangings in the country, where equalizing bars are used, but these are not in general use yet. In the chrome works, while repairs were being made the workman drove a wooden plug into the steam outlet, to prevent water dripping upon him, the boiler being in a battery, and the stop valve slightly leaking. When repairs were completed, he went away, forgetting to remove the plug. The boiler was filled with water, and fires started. In about four hours it exploded, killing one man and wounding several; the damage was heavy. * * * The tug-boat explosion was caused by the tug having a very heavy tow in a storm, entering Chicago harbor. The water was thrown off the crown sheet; it was burned and came down. All of these exploded boilers were regarded as in good condition at the inspection preceding the accident, and I am confident that these explosions were occasioned by some unforeseen circumstance which inspection could not have prevented. * * * *

The present report is brought down to December 31st, and covers a period of sixteen months. During this time the *number of inspection visits made was* 22,612, *and the number of inspections made* 44,763. Of these 14,181 *were internal and complete.*

The hydraulic test was applied in 3,149 *cases*, mostly new boilers in the yards of manufacturers. * * *

Our work has brought to light many defects that it will be well for steam users to consider. They go to show that boilers are often on the verge of disaster, when a feeling of security prevails.

The defects in all discovered were 24,040, of which 6,149 needed immediate attention, and we set them down as dangerous.

The cases of *furnaces out of shape were* 1,058—172 *dangerous. Fractures* 1,893—884 *dangerous.*

These defects are usually in consequence of bad management. The boilers are overheated, and suddenly cooled. Cold water is often fed into a hot boiler where the water is very low, and portions of hot tubes and flues are exposed. The inevitable result is fractures of greater or less extent. This difficulty is liable to manifest itself at the riveted joints, which are the weakest points in the boiler. If from poor workmanship the plates are over-strained at the riveted joints, fractures will most certainly follow.

Sometimes they run along the line of the rivets from one hole to another, while at others they run from the hole to the edge of the plate. For instance, by using "drift pins" by which to bring the holes in the sheets to coincide, the fracture may be started. I will illustrate by the following figures. In Fig. 1 it will be seen that the punched holes in the plate do not coincide. This is a sectional view. Fig. 2 is the same difficulty looking down upon the plate.

Now by using a tapering iron pin to bring these holes to coincide, there is great danger of producing weaknesses and defects, as will be seen in Figs. 3 and 4.

In one instance the iron of the plate is crushed in front of the rivet, while in the other case the plate outside the rivet has broken through to the edge. A case came under our notice some time since where a plate was cracked in the line of the rivet holes. The boiler leaked and the owner had it caulked, but it continued to leak. Internal inspection discovered the cause. The defect is illustrated in Fig. 5, where will be seen an inside and outside view of the piece cut out. The left hand, or outside view, it will be noticed, has all the appearances of having a perfect joint. These cases are not uncommon, and if from defective workmanship the difficulty is incipient in the boiler, the wear and tear resulting from use will soon develop it in dangerous form.

Burned Plates 1,465—552 *Dangerous.*—These defects are occasioned by urging fires too fiercely—too small boiler capacity—and accumulation of sediment and scale.

Blistered Plates 3,623—670 *Dangerous.*—This defect arises from a laminated sheet which is always liable to be over-heated in consequence of the resistance to the conduction of heat, occasioned by the want of homogeneity or soundness. When such a sheet is found on the fire surfaces it should be at once removed and a new one substituted. Patching, where any considerable portion of the sheet is affected, is poor economy.

Cases of Deposit of Sediment 3172—607 *Dangerous. Incrustation and Scale* 3,643—558 *Dangerous.*—These defects are the very worst to which boilers are liable. Most waters used in steam boilers contain solid matter in solution, which is precipitated by heat. This matter deposits on the bottom, crown sheet, or flues of the boiler, and if not speedily blown out, it burns on and forms a hard scale. If this scale is allowed to remain, it prevents the heat from passing readily through the iron to the water, and the result is the iron is badly burned. In a former report (1874) I discussed this subject quite fully, therefore will not occupy time or space for its repetition.

External Corrosion 1,538—533 *Dangerous. Internal Corrosion* 681—199 *Dangerous.*—The work of corrosion is insidious, whether it is external or internal. A boiler that is set in brick-work may leak at the seams, and corrode the plates adjoining, and yet there may be no indication of danger. So, by the use of impure water, a very dangerous process may be going on inside the boiler. In boilers covered more or less with scale its presence is often detected by red streaks where the scale is cracked. It attacks the edges of plates at the joints, and around the rivet heads. Sometimes it will attack two boilers working side by side. One will be corroded in the front part, and the other in the back part. Sometimes different sheets in the same boiler will be corroded, while others remain intact. Again, boilers will be found in what is known as a "*pitted*" condition. This is manifested by small spots in close contact being eaten into the sheet. It looks like a pock-marked face and is sometimes confluent; and what is strange about this is, that often certain sheets in the boiler will be attacked while others will remain clean and smooth, and the iron will bear the same brand on each plate. It is well known that iron ore even from the same mine is not always chemically the same; certain impurities will be found in some places which do not exist in others. And in the manufacture of boiler iron there is no doubt but that the sheets are chemically slightly different; hence when the boiler is constructed the presence of acids in the water may excite galvanic action. This would account for the different manner in which boilers are affected. Figure 6 will illustrate the effects of corrosion.

This is a portion of the water-leg of a steamboat boiler—the condition of which was discovered by inspection. Our draughtsman has made a very correct drawing of this relic, which can be seen in our office. It is in many spots corroded to the thinness of paper. It had been patched, but there was not metal enough to hold the patches securely. This steamboat was used in summer as an excursion boat, and thousands of people rode over the boilers in the condition represented above. (The patches are removed). There are doubtless a great many similar cases, which may, in some measure, account for the fearful accidents that appall the country from time to time. Another case of corrosion is illustrated by Fig. 7.

This was discovered by inspection. The outer and inner side of the sheet is shown in the drawing; also a cross section. The hole in the center of the sheet was made by the inspector's chisel. The iron was little thicker than paper. The piece of plate can be seen in this office. Fig. 8 represents a portion of the inner plate of a water-leg of a locomotive boiler. Corrosion attacked the plate around the stay-bolts, as represented by the radiating dark lines. The other end of the stay-bolts was eaten nearly off. We judge from appearances, that in tapping out the holes for the stay-bolts, a strain was brought to bear which disturbed the fibre of the iron, or perhaps I should say the skin of the iron, imperceptibly, however, to the casual observer.

The difficulty was further aggravated by the unequal expansion and contraction of the two sides of the water-leg. The inner sheet forming the side of the fire-box was subjected to greater heat, and this continual, though imperceptible, action assisted in increasing the difficulty.

Impure water found this disturbed point the most open to attack, and the result is as we find it here. The furrows are eaten in quite deep, and it looks like the work of a tool.

Internal Grooving 203—80 *Dangerous.*—Our views in regard to this defect are not changed, but time, and wider experience, tend to confirm the views which we have heretofore expressed.

Water-Gauges Defective 961—232 *Dangerous.*—These attachments are very liable to get out of order. They should be carefully watched, and if the water is bad they should be cleaned often. Engineers are frequently deceived by an inoperative water-gauge.

Blow Out Defective 335—143 *Dangerous.*—The valves in this apparatus are liable to disarrangement from pieces of scale lodging on the seats. Hence, when the boiler has been blown out and refilled, if the valve does not close tightly, the water will leak out imperceptibly, and damage will result from overheating. Engineers should never fail to ascertain the condition of the water in their boilers the first thing upon entering the boiler-room in the morning. Never start the fires until this has been done. A great many boilers have been permanently injured by neglect of this rule.

Safety-Valves Overloaded and Out of Order 625—273 *Dangerous.*—In one instance the safety-valve was found inoperative and so fast that no allowable pressure could have started it. The boiler to which it was attached exploded, doing large damage. We have found several instances where, from corrosion of valve guides or stems, they were inoperative at the pressure designated. They were in good condition originally, but from neglect between the inspector's visits, they were found as above indicated. A safety-valve should be raised every day. It is very little trouble to do it. The usual number of cases where the valve was overloaded has been found. Some boiler tenders seem to think an escape of steam from the safety-valve is dangerous, and they hang on the lever pieces of iron, or bricks, or anything that comes handy. We have found several cases where the escape pipes from the safety-valves were too small, or where they were stopped up entirely.

Pressure Gauges Out of Order 2,868—649 *Dangerous.*—The variations of these were from —45+70. When a gauge is neglected and implicitly trusted, the condition of things is liable to be very dangerous. Gauges need inspection as much as boilers, and their true condition can be ascertained only by careful comparison with a gauge known to be correct.

Boilers Without Gauges 811—19 *Dangerous.*—Those indicated as dangerous were where high pressures were used. Every boiler should be provided with some reliable means of ascertaining the pressure of steam.

Fig. 1.

Fig. 2.

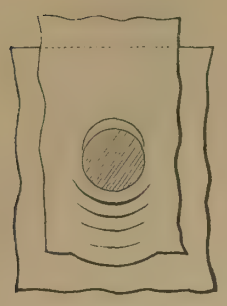


Fig. 3.

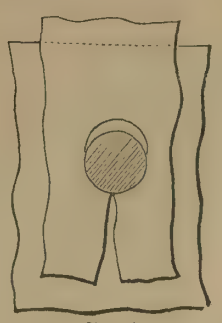


Fig. 4.

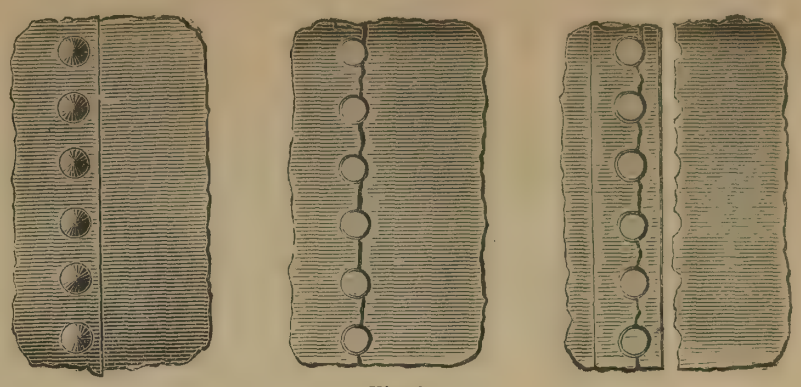


Fig. 5.

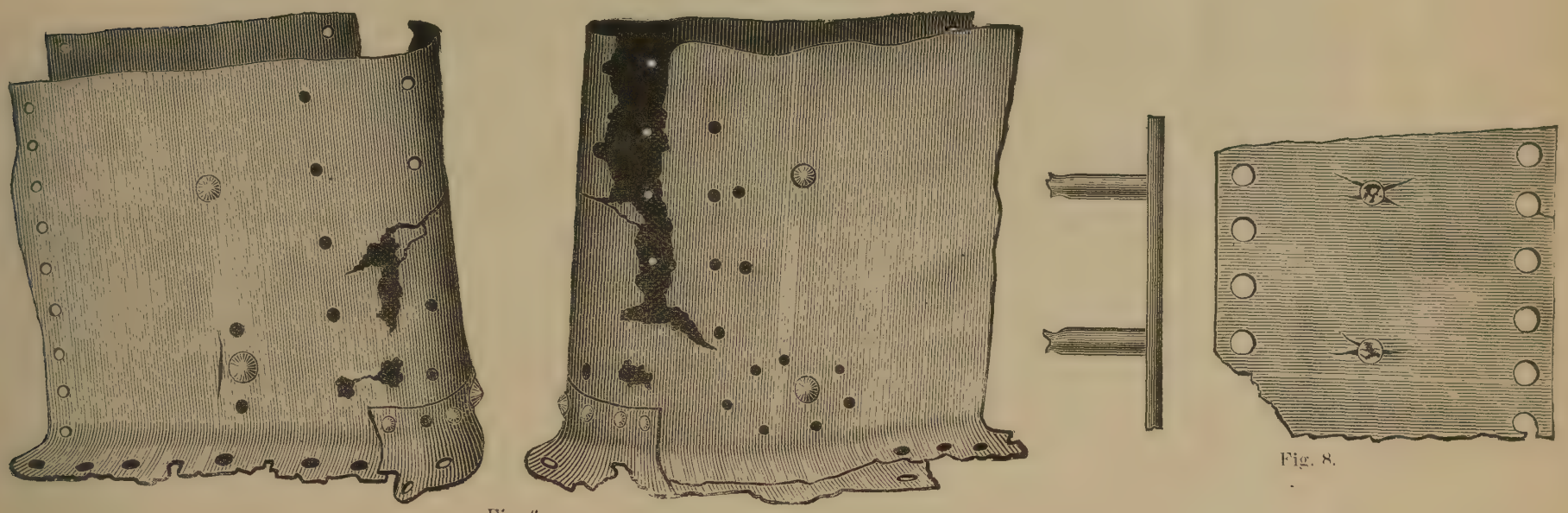
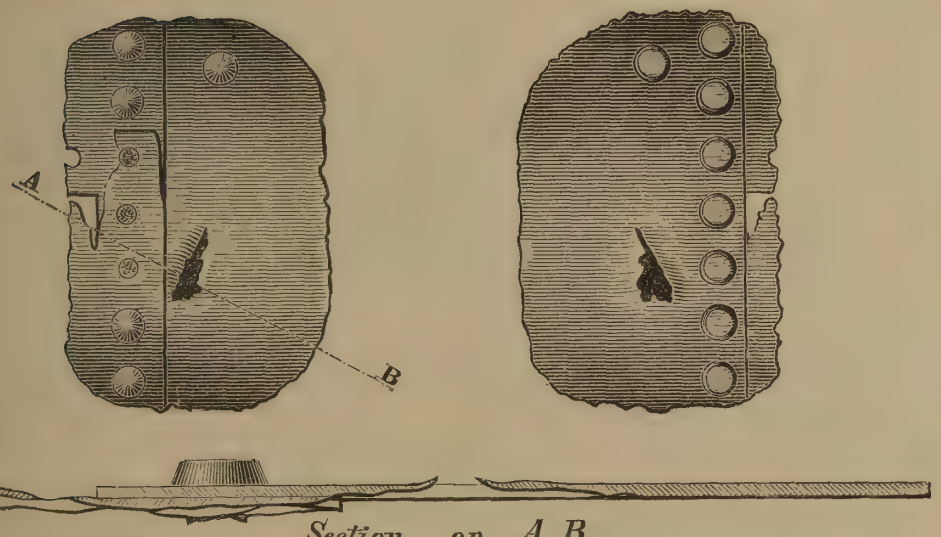


Fig. 6.



Section on A, B.

Fig. 7.

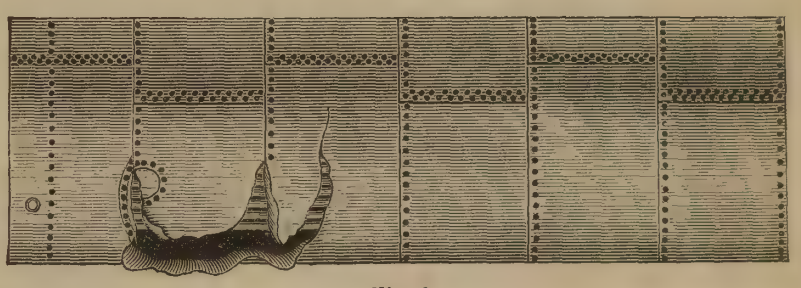


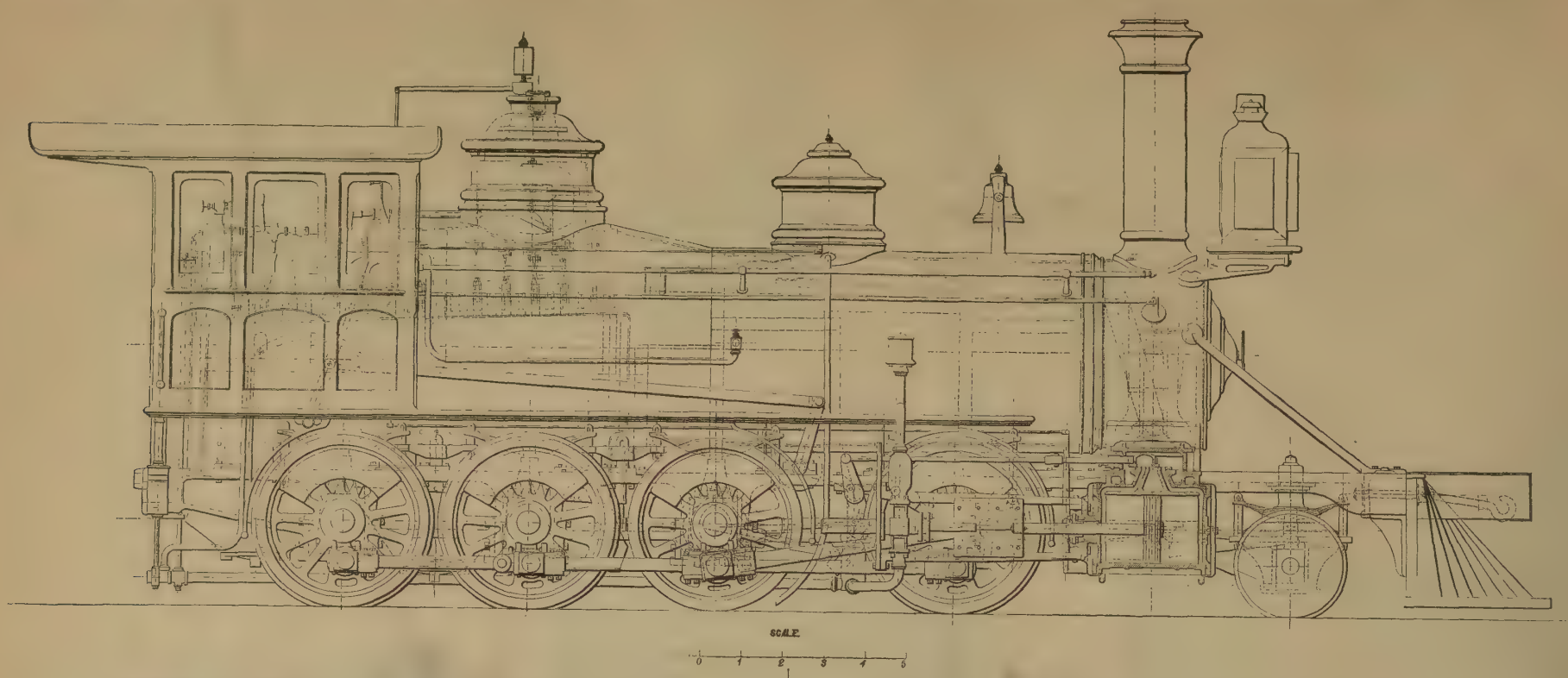
Fig. 9.

Deficiency of Water, 196—93 *Dangerous.*—These cases are from different causes. They may result from too limited boiler capacity for the amount of steam required. Leaks are a fruitful cause, and as has already been stated, the valve of the blow-out is sometimes prevented from closing tight, on accounnt of some foreign substance lodging upon its seat. A case came to our notice where three boilers were set in a battery. From some cause the blow valve of the center boiler was not perfectly seated, and the water leaked out of this boiler during the night. In the morning the engineer tried the water in the first boiler and found it at proper height, but did not try the others, supposing they must be in proper condition. The fires were started, and when steam reached a pressure of 48 lbs., it was sufficient to force down the red-hot plates in the empty boiler as shown in Fig. 9.

Insufficient Bracing and Broken Braces and Stays, 968—485 *Dangerous.*—These defects are partly attributable to faulty construction, and partly to want of proper examination and care. We have found, in some cases, the stays nearly eaten off by corrosive action. And in many instances the bracing is very meager. Flat heads are left without support, so that at every revolution of the engine they move to and fro. This process soon develops fractures at or near the joint uniting the head with the shell. Sometimes, however, fractures will occur in the body of the head itself. There are rules for the proper bracing of boilers, and they should not be overlooked.

Boilers Condemned, 216.—These were in such condition that it was absolutely unsafe to run them any longer. In these hard times many steam-users are inclined to run their boilers just as long as they will hold together. On one occasion, when a set of boilers had been examined, and pronounced unsafe, the owner was very much displeased and showed no little temper. In another instance a manufacturer said, "I know my boilers ought to be examined, but if you do it, you will condemn them, I am afraid, and I cannot afford to put in new ones now." All the defects enumerated in this report go to show that inspection is absolutely necessary to keep boilers in economical and safe condition. I have given little time comparatively to each kind of the defects discovered, because in the reports of 1873 and 1874, particularly the latter, much space was given to them, their cause, and so far as I could, the remedy. We aim to be reasonably modest in giving an opinion of any defect which we have not thoroughly studied. The range of our business brings within its scope almost all defects common to steam boilers. And we find so many instances where persons, anxious to give an opinion, have jumped wide of the mark, that we take time and care in forming an opinion. Sometimes a new feature is developed in the wear and tear of boilers, but instead of having one solitary case from which to make up an opinion, we usually have several similar in character, and these with the circumstances surrounding them, furnish ata from which we can usually arrive at very satisfactory, and, we believe, just conclusi.ns.

[*To be continued.*]



CENTENNIAL EXHIBIT OF BALDWIN LOCOMOTIVE WORKS.

IV.

FREIGHT LOCOMOTIVE, "CONSOLIDATION" PATTERN.

For the Lehigh Valley Railroad. Four feet eight and a half inches gauge.
Fuel, Anthracite Coal.

LOCATION: SECTION E 7, COLUMN 43.

CYLINDERS.

Diameter	1 ft.	8	inches.
Stroke of piston	2 ft.		
Length of steam-ports	1 ft.	4	"
Width of steam-ports		1¼	"
Width of exhaust-ports		2½	"
Travel of valve		5⅜	"
Outside lap of valves		¾	"
Inside lap of valves		1/32	"
Exhaust nozzles—variable.			

WHEELS.

Diameter of driving-wheels	4 ft.	2⅝	"
Diameter of truck-wheels	2 ft.	6	"
Distance between centres of front and rear driving-wheels	14 ft.	9	
Total wheel-base of locomotive	22 ft.	10	"
Total wheel-base of locomotive and tender	46 ft.	2	"
Diameter of driving-axle journals		7	"
Length of driving-axle journals		8	"
Diameter of main crank-pin bearing		5	"
Length of main crank-pin bearing		5	"

BOILER.

Outside diameter of smallest ring of boiler	4 ft.	6	"
Thickness of boiler plates (iron)		½	"
Number of tubes	198		
Length of tubes	11 ft.		"
Outside diameter of tubes		2	"
Length of fire-box inside	9 ft.	10	"
Width of fire-box inside	2 ft.	9¾	"
Depth of fire-box inside (sloping)		44½–55	
Thickness of fire-box plates (steel), sides and back		5/16	"
Thickness of flue-sheet		½	"
Thickness of crown-sheet		⅜	"
Square feet of grate surface	27.6		
Square feet of heating surface in fire-box	149		
Square feet of heating surface in tubes	1132		
Total square feet of heating surface	1281		

WEIGHT.

Weight of engine in working order	100,000	pounds.
Weight of engine on driving-wheels	88,000	"

MATERIALS.

Boiler, J. L. Bailey & Co's "Pine" Iron; *Fire-Box*, Bay State Iron Co's Homogeneous Cast Steel; *Tires*, Standard Steel Works' Crucible Steel; *Truck Wheels*, A. Whitney & Sons' Double-plate Chilled Wheels; *Flues*, Morris, Tasker & Co's Lap-Welded Charcoal Iron Boiler Tubes; *Injector*, Rue Manufacturing Co's "Little Giant" Injector; *Steam-Gauge*, H. Belfield & Co's; *Brass and Copper Piping*, Bridgewater Iron Co.; *Jacket Iron*, W. D. Wood & Co's Patent Planished Sheet-Iron; *Head-Light*, Kelly Lamp Works.

REMARKS.

Locomotives of this class have been used on the Lehigh Valley Railroad since 1866, in which year the locomotive "Consolidation," from which the class has taken its name, was built by the Baldwin Locomotive Works in accordance with the plan and specifications furnished by Mr. Alexander Mitchell, then Master Mechanic of the Lehigh and Mahanoy Railroad.

On this division of the Lehigh Valley Railroad, over maximum grades of one hundred and twenty-six feet per mile, the maximum load is thirty-five loaded four-wheeled coal cars (three hundred and twenty-nine gross tons of cars and lading), and the usual load twenty-five loaded four-wheeled coal cars (two hundred and thirty-five gross tons of cars and lading). On the same division, over a grade of seventy-six feet per mile, one of these engines draws a maximum train of one hundred and forty empty four-wheeled cars (four hundred and seventy-six gross tons) at a speed of eight miles per hour. Its usual train is one hundred empty cars (three hundred and forty gross tons). Compared with the "Ten-Wheeled" pattern of locomotive, cylinders eighteen by twenty-four, driving-wheels four and four and a-half feet in diameter, weight on driving wheels about sixty-thousand pounds, the performance is as shown in the following table:

	Grade 126 ft. per mile. Gross Tons of Train.	Grade 76 ft. per mile. Gross Tons of Train.
Maximum Load of "Consolidation" Locomotive,	329	476
" " of "Ten-Wheeled" "	235	340
Usual " of "Consolidation" "	235	340
" " of "Ten-Wheeled" "	169 to 200	221

Consumption of fuel—"Consolidation" Engine, 3¾ tons daily.
" " "Ten-Wheeled" " 3¼ "

The ordinary repairs for a series of years have been one mill per mile run greater for the "Consolidation" than for the "Ten-Wheeled" engine.

On the Wyoming Division of the same railroad, from Sugar Notch to Fairview, the grade is one in fifty-five (ninety-six feet per mile) for twelve miles in length, combined with curves of eight and ten degrees radius. The curves are frequent, and there are but two tangents, each less than one mile long, in the whole twelve miles. Up this incline, engines of this class can take forty loaded four-wheeled coal cars. The usual train is thirty-five such cars, which are taken at a speed of twelve miles per hour. The cars weigh, each, three gross tons, eight hundredweight, and carry, each, six gross tons of coal. The weight of train, therefore, which a "Consolidation" engine takes up the grade combined with curves, as stated, is from three hundred and twenty-nine to three hundred and seventy-six gross tons.

(To be continued.)

THE REMOVAL OF NIGHT SOIL.

VI.

THE MATTHEWMAN & JOHNSON EXCAVATING PUMP & DEODORIZING APPARATUS.

No apology is needed for constant presentation before the public of such modes of disposing of fœcal matters, as are subservient to health, decency, economy and comfort. With all our boasted civilization, we have not yet reached that point at which we are safe from self-contamination; nor has that commendable modesty and æsthetic tendency, which has developed in so many ways and even, at times, rushed into squeamishness, yet made general an unobtrusive and inoffensive mode of removing night-soil.

We are glad to chronicle that in the larger cities such regulations are enforced as render it imperative to employ some other system than the old and disgusting pole and bucket abomination.

The advantages of a system of odorless excavation of vaults and cess-pools scarcely need rehearsal. The cleanliness and decency of the process, aside from its sanitary recommendations, alone should cause its enforcement. In a money point of view we have these points gained: The saving of time; the gain of working hours, as the system may be worked the regular ten hours per day instead of a few hours in the night; daylight giving its advantages over the flickering rays of a lamp, or the faint light of the moon.

We give herewith cuts showing the Matthewman & Johnson excavating and deodorising apparatus, made in New Haven, Conn.

There is a tight cylindrical tank mounted on a truck, and holding 400 to 600 gallons, with proper inlet and outlet closed by caps and gallows screws. A four-inch

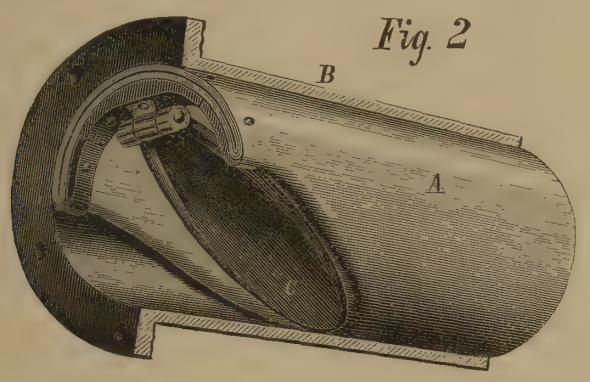
smooth-bore rubber hose, with "embedded spiral," is used, in lengths of 15 feet, for suction and forcing. It is coupled by fittings which are the same on both ends, and which, having inclined projecting lugs, may be instantly connected or released, on turning a nut. A cap closes each coupling when disconnected. The air as displaced is driven through a deodorizing can (shown in front of the tank), in which it is passed through any desired and efficient disinfecting and deodorizing solution.

On the rear end of the receiving tank is placed an indicator for the purpose of registering the amount of material in the tank, thus giving the vault-owner an opportunity to verify his bills.

The pump seems peculiarly adapted for the purpose to which it is applied.

The valve proper (see Fig. 2) is simply a flexible rubber tube, A, placed within the metallic pump tube, B, and fitting the same closely, while at the receiving end the

Fig. 2



rubber tube is folded upward, until its two surfaces meet, and bolted securely, so that the material pumped does not pass through the rubber tube, but between its outer surface and the inner surface of the metallic tube containing it. As an adjunct to this rubber valve, there is a guard plate, C, placed just in front of the fold of the rubber tube, and hinged at its top end, while its lower ends rests on the lower inner surface of the pump tube. This plate when closed stands upon an angle and opens readily upward with the rubber valve. The offices of this guard plate are two-fold, viz., to protect the rubber valve from puncture or injury from sharp substances when entering, and to prevent the rubber from being strained or forced backward. The action of this valve is this: the rubber tube or valve collapses, to allow the material to pass, while it expands or comes back to its original position, to close or check the backward flow—the greater the pressure within the pump the more tightly will the rubber be pressed against the inner surface of the pump tube on all sides—while the elasticity and form of this rubber valve allows it to pack around and over any foreign substance which may stop under it, sufficiently tight to hold it, until the next stroke of the piston carries it through. Two of these valves are used in the pump; one being placed in either end of a nearly horizontal metallic tube, and separated by a few inches; while at the down stroke the first valve is closed, and the material forced out through the second.

It will be seen that the labor of moving the vault matter is thus divided: the suction column being moved at one movement of the lever, while the force column is moved at the other. The cylinder being placed upright at the top of the pump, only the lighter or watery part of the matter comes in contact with the piston, so that there should be no grinding out of the cylinder with sand. The receiving end of the pump-tube being elevated a little higher than the discharge end, all stones and heavy substances are inclined, by their own weight, to move forward to the mouth of the second valve, aftar passing the first; so that they should not remain in the pump or interfere with the working of its valves.

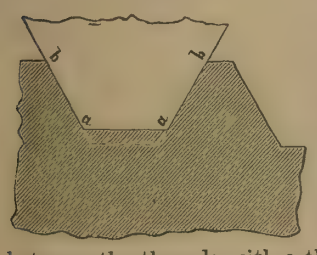
One of these pumps is exhibited in the Hydraulic Annex to Machinery Hall, and is passing a mixture of coal tar, rags, mud, etc., which would clog up, or refuse to pass through, any ordinary pump of the same capacity for pumping water. The entire apparatus has received favorable testimonials as to its superior qualities for the purposes for which it is intended.

G.

FRICTIONLESS TAPS.

It is well known by mechanics that a tool to easily and properly cut metal, requires a clearance between the back of the tool and the surface acted upon. This principle is applied in the construction of nearly all tools except in solid dies for threading bolts and gas pipe, and in the ordinary fluted taps for tapping holes.

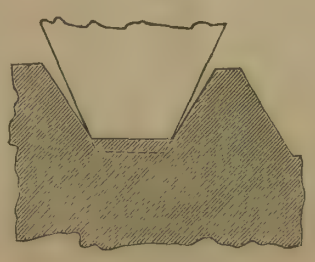
Fig. 1



In the common fluted taps where the thread is cut in the lathe, and the points of the thread are filed away to give a clearance or relief to their cutting edges, there is still the sides of the cutting edges without clearance, as shown at a, b, Fig. 1.

Various plans have been adopted to give relief to these sides. The most common one is that of filing in between the threads with a three-cornered file; another method is when the same result is produced by machinery, either in the lathe or milling machine, by causing the tool to advance or recede as the blank tap is being cut, producing not a perfect cylindrical section, but one approaching a triangle or square, as the finished tap is to be either a three or four fluted one. But in all these plans there remains this unnecessary friction, that is, the friction of the cutting edges, of all subsequent cutting teeth, rubbing along over the finished work of those cutters which have done their work before.

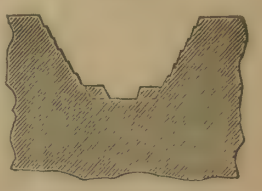
Fig. 2



In the construction of a specimen tap shown in Machinery Hall, Centennial Exhibition, at Cornell University stand, B-68, a different method has been adopted—one that not only gives a relief to the cutting edges of the tap, but eases the sides as shown in Fig. 2, and one that can be produced by the ordinary lathe. The work consists in cutting the thread and turning the taper in the usual way. Then, that the subsequent operation may be better observed, the blank is heated to change its color. The blank, before being fluted or grooved, is put in the lathe with the foot-stock of the lathe set back; that is, the reverse of position it occupied when turning the taper on the tap, and then with a tool somewhat more acute than the one used for cutting the thread, the bottom of the thread is turned away until a new angle is formed on the sides of all threads up to about one diameter of the tap, which is left in its original condition to clear out and leave a finished hole. When such a tap is fluted and the outer surface between the flutes filed away, all parts of the tap have a clearance, and so far as the cutting edges are concerned, a better clearance than if made by either of the old methods.

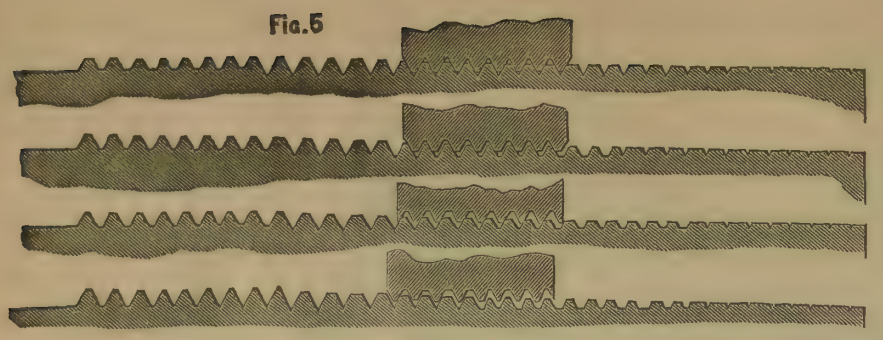
Fig. 3

Fig. 4



Another invention applicable to this or any other style of tap, is shown in Figs. 4 and 5. In the ordinary tap, with the taper four or five diameters in length, there are far more cutting edges than are necessary to do the work; and if the taper is made shorter, the difficulty of too little room for chips presents itself. The evil results arising from the extra cutting edges are that, if all cut, then it is cutting the metal uselessly fine—consuming power for nothing; or if some of the cutting edges fail to cut, they burnish down the metal, not only wasting power, but making it all the harder for the following cutters. One plan to avoid this is to file away a portion of the cutting edges; but the method adopted in the University tap is still better. Assume that it is desired to make three following cutters, to remove the stock down to the dotted line in Fig. 2. Instead of

Fig. 5



each cutter taking off a layer one-third the thickness and the full width, the first cutter is cut away on each side to about one-third its full width, so that it cuts out the center to its full depth, as shown in Fig. 4, the next cutter cutting out the metal at A, and the next at B. This is accomplished by filing, or in any other way cutting away, the sides of one row of the teeth, all the way up; next cutting away the upper sides of the next row and the lower side of the third, leaving the fourth row (if it be a four-fluted tap) as it is left by the lathe, to insure a uniform pitch and a smooth thread.

JOHN E. SWEET.

Dep't of Mech. Engineering, Cornell University, Sept. 5, 1876.

HONOR TO WHOM HONOR IS DUE.—The POLYTECHNIC REVIEW has always been scrupulously careful in acknowledging its indebtedness to its contemporaries, for all articles and items which have been taken from them; and has carried this so far as to refer to date and page of source, even in the case of each of the immense number of brief "Review" items under the head of "Progress of Science and the Arts." We regret to say that some of our cotemporaries are not so careful in giving credit; and a few of those showing more good taste than good manners in thus reproducing our articles uncredited, are those from whom, by reason of their high standing, we should expect better things. We beg, therefore, to say that we would appreciate the formality of due acknowledgment of our articles equally with the honor of their selection and republication. THE EDITORS.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The 100-*Ton Gun.*—The 100-ton gun has just been completed by Sir W. G. Armstrong and Co. of the Elswick Ordnance Works, Newcastle-on-Tyne. Built for the Italian Government, this monster piece of ordnance is the first of eight guns to be placed on board the turret ships Duilio and Dandolo, built the one at Spezia and the other at Castellamare, near Naples. The first of these vessels was launched at the arsenal of Spezia a few weeks ago, but it will yet require twelve months or thereabouts to complete her equipment, and within that time it is expected that the Elswick firm will have the three other guns required to complete her armament ready for delivery. With reference to the ships which are to mount the heaviest ordnance yet constructed, we may merely remark that each is furnished with two turrets, which, instead of being in the centre line of the vessel, are placed towards the sides, so as to get a clear fore and aft fire from either turret. The inside diameter of either turret is about 26 ft., and the outside 32½ ft., while each will weigh, including its guns, about 7000 tons. Each turret will be able to make one complete revolution in about a minute, and will be provided with hydraulic locking bolts to stop the turret when desired at the loading position. These bolts are of sufficient power to stop the whole mass at a moderate speed, and stay it in position during the operation of loading.

It is almost needless to remark that the 100-ton gun which left the Tyne last week for the arsenal of Spezia is the heaviest and most powerful piece of ordnance in the world, being 20 tons heavier than the huge guns with which it is proposed to arm the Inflexible. It is constructed on the well-known Armstrong principle, the inner barrel being of steel, rifled with twenty-seven grooves, the spaces between which are about equal to the width of the grooves themselves. The weight of the gun is 101½ tons; its extreme length is 32 ft. 10½ in.; the length of the bore is 30 ft. 6 in.; and the diameter is 17 in. The outside diameter of the gun at the muzzle is 29 in., that at the breech being 77 in. The barrel is in two pieces, made into one in the building up. There are three layers of coils over the thickest end of the gun, and the steel tube is in two pieces, joined by a double ring, so as to make one tube. The rifling is an increasing spiral, on what is called a parabolic development, winding up with a twist of 1 in 45 calibres. The depth of the grooves is ⅛ in. throughout. The details of the loading gear are similar to those of the Inflexible gun, with slight modifications to suit the size and disposition of the guns. There is a preponderance or superior weight at the breech end of about 4 tons, which gives stability in working, inasmuch as the weight is always tending in one direction. The trunnions are not placed on the largest diameter of the gun, as is usual with heavy ordnance, but further forward, where the diameter is considerably reduced. Rotation is given to the projectile, which quits the gun at a velocity of about 1400 ft. per second, not by the usual studs fixed in the projectiles to fit the grooves, but by a copper gas check fixed into the breech end of the shell, which has projections upon it corresponding with the rifling grooves of the gun. Where the check bears against the shell, the shell is so formed that the check on being crushed against it by the pressure of the explosion and the charge presses firmly about it, and the gas check being caused to rotate by the rifling grooves causes the projectile to turn to take the same rotation. The loading gear is hydraulic. Upon opening a valve the ram-head advances and forces the shot up the bore to its seat against the charge. After firing, the gun is brought to the loading position and slightly dperessed. Then the hydraulic ram, which has a sponge head, advances rapidly up the bore, and when it reaches the breech end of the bore a valve in the head is opened and a powerful jet of water is brought to play on the powder chamber; thus, at the same time aiding in cleaning the bore, and preventing the possibility of any remnants of fire being left in the chamber. After the rammer has been withdrawn, the cartridge and shot are in turn raised by a hydraulic cylinder to their proper position in front, and on a line with the muzzle, this and the remaining operation being performed by one man without moving from his seat beside the levers. In the working of ships, such as the Devastation, relays of forty men each are required every ten rounds of rapid firing, but it is expected that the use of hydraulic machinery will enable the same work to be done by ten men in the 100-ton gun, and with considerably less fatigue. One man per gun is sufficient for ramming it in and out, elevating or depressing; one man for elevating the shot and charge, sponging, cleaning and ramming home; one man for sighting the gun and firing; and one man for priming the vent.

The weight of the armor-piercing projectile is 2000 lbs., and that of the proof shot 2500 lbs., being 1240 lbs. more than that of the 81-ton gun. It is calculated by Captain Noble that the work developed by the shot when it quits the muzzle will be about 39,000 foot tons, as compared with a power of 24,000 foot tons realized in the 81-ton gun. In other words, it is calculated that the one gun will give thirty per cent. greater effect than the other. Of course it is by no means certain that in so ponderous a weapon the exact estimated work will be attained, but approximately a power equal to raising 39,000 tons a foot is confidently expected. The aggressive force of the shot is estimated as equivalent to piercing an armor plating 30 in. thick, with the usual backing of teak, but the greatest thickness of plating on the Dandolo and Duilio will be no more than 24 in., while the maximum thickness of the plating in the turret will only be 17 in., the plating of the ship being thus the same thickness as that of the Inflexible, and 6 in. less than the calculated penetrating power of the guns which the vessels will mount. The cartridge measures 52 in. in length, and 15½ in. in diameter. It is made up of 360 lbs. of pebble powder, in blocks of 1½ in. cube. Instead of being mounted on a gun-carriage of the usual ponderous description, the gun is elevated on a pair of small trunnion blocks, connected with compressers, which are placed immediately behind the trunnions, so that the strain of the recoil is directly given off in the line of its action. These blocks with their accessories will weigh 35 tons, and the compressers, used for the purpose of running the gun in and out, will be worked in common with all the other mechanism of the gun by hydraulic power, applied at a pressure of 800 lbs. to 900 lbs., from a pumping engine which may be erected in any part of the vessel. [*The Engineer*, xlii, 102.]

—A telegram from Montreal says: "As stated yesterday, Aug. 8, the Premier proceeded with the harbor commissioners to Lake St. Peter to examine the work of deepening the channel of navigation now in progress on the lake and at various places between it and this port. Both Mr. Mackenzie and the commissioners were very well satisfied with what has been and is being done, and were particularly pleased and surprised by the superior facility and efficiency of the new plan of removing the ledge rock at Cape St. Charles by means of the toothed dredge. In some places the channel is being cut to the full depth of twenty-five feet to avoid going over the difficult work twice. The changes in the course of the channel seem to insure all the advantages anticipated. [*Eng. News*, iii, 270

A Coal Cutting Machine, recently put to work in a mine at New Straitsville, Ohio, is described as follows:

The machine proper consists of a bar of iron or steel, two and a-half feet long by two inches square, in which is placed twenty-five picks or cutters. These cutters and the bar in which they are securely fastened are driven by two small engines using compressed air as the motor. The engines, being so very small (4×5 inches) are enabled to go fully five hundred revolutions per minute in perfect safety, thereby imparting a rotary motion to the head, where the cutters are placed, of one hundred revolutions per minute, every revolution driving the head in one-third of an inch, by means of screw rod and nut similar to Frim's miners coal drill, now so extensively used in the Shenango Valley. By reversing the motion the same screw which drives the head in, draws it out for a new cut into the coal.

The machine is two feet nine inches high, and at present six feet long, and is calulated to make a "bearing in" five and a-half feet deep and but *four inches high.* The power (compressed air) is obtained by two coupled air-pumps placed at the air shaft, and carried to the cutter through rubber pipe one and a-half inches in diameter. The total cost of all will not exceed $3,000.

It is claimed that with this machine three men can "bear in" and drill the holes for a blast in one hour which would require four men a whole day; or three men and the machine can do as much as thirty miners can in a given time. It is also said that the wastage is less than that made by hand diggings. [*Am. Manuf.* 8, 14, 1876.]

The Great Oil Pipe.—The Pennsylvania Transportation Company consummated contracts, August 11, with the Pipe Manufacturers' Association for three hundred miles of pipe. Operations will commence immediately, and the line to the seaboard completed before the first of December. The engineers of the line are now receiving bids for pumps and boilers. The route is definitely located, and bonds are being taken rapidly at par. [*Eng. and Min. Jour.*, xxii, 151.]

The South Boston Flats are being rapidly reclaimed, and will probably be finished by Spring. The sea-wall is nearly finished, and the contractors are also building the walls for four docks, 800 and 600 feet in depth. The area to be enclosed by the State is about 12,000,000 feet, which will give a great extent of available wharf front, and a new avenue called Northern avenue, is to be built. The Boston Wharf Company is filling up the eastern portion of the flats, and in less than a year 100 acres of solid ground will be ready for occupancy. [*Eng. News*, iii, 283.]

—The matter of the levees is once more being agitated, and inquiry has been made as to when the usual surveys will be made. Gen. M. Jeff Thompson being quite ill in Missouri, will not make the survey this year, but W. C. Melvin, A. F. Wrotnoski and H. B. Thompson, of the Board of State Engineers, will accompany the Commission of Engineers, in September, for the purpose of assisting them in locating, and to stake out the levees, to be built during the levee year—1876–77. It is supposed the commission will start between the 5th and 10th of September. They will also be accompanied by Mr. M. W. Danton, engineer for the Louisiana Levee Company. [*Eng. News*, iii, 283.]

—The report of Gen. Newton and Col. Adams to the directors of the Brooklyn Elevated Railroad Company favors the single-rail plan of Roy Stone. The rail consists of a triangular trestle work, and the car is saddle-shaped. One of the advantages secured by this arrangement is the impossibility of a car or engine leaving the track, except by being lifted a considerable distance. Placed on single posts on the side of the street, it is estimated that a road constructed on this plan would cost $100,000 a mile, while the cost would be $130,000 per mile if the road was to span the street. [*Eng. News*, iii, 283.]

—A trial was made on the narrow-gauge railroad between Des Moines and Ames, thirty-eight miles, as to the quantity of fuel consumed. The train consisted of the engine, weighing 14 tons; mail and express car, 7 tons; two coaches, 35 passengers each, 14 tons, making a total of 35 tons. The locomotive was built by the Grant Locomotive Works, has six 42 inch drivers; cylinders 10 inches in diameter, with 16-inch stroke. The trip to Ames and return was made with 1,000 pounds of bituminous coal, or 13½ pounds per mile. The rate of speed was twenty miles per hour. The trip was also made with one coach less, with 740 pounds of coal, or 9¼ pounds per mile. The grades are the average found on all roads in Iowa. [*Eng, News*, iii, 283.]

The New Pier, N. R., at the Battery, N. Y., is the only pier which is being constructed entirely of stone and concrete masonry. It is 452 feet in length, by 80 feet in width, and will be finished this year, five years after the work was commenced. [*Eng. News*, iii. 287.]

MINING, METALLURGY AND MINERALOGY

On the Exhaustion of English Mines.—M. Gruner has recently been speaking on the probable exhaustion of English Mines. In England, he said, the production of a man per annum was 300 tons. In Prussia and France, in the more favored districts, it was 200 tons, while in Belgium and the Nord, where the beds were poor, the production seldom exceeded 150 tons. In England in 1872, 400,000 men were engaged in producing 120,000,000 tons. It had been calculated that if the production continued to increase at the rate of the last 40 or 50 years it would reach 4,000,000,000 tons in the year 1950, so that the mines would be exhausted before the end of the next century. He pointed out that to produce these 4,000,000,000 tons, even at the rate of 300 tons per man, 13,000,000 workmen would be employed, and if their families were added at the rate of five to one, the total population engaged in mining in England in 1950 would be about 65,000,000. Such figures show the absurdity of the theory. He would estimate the maximum production of England for all times at 250,000,000 tons, which would assume 1,000,000 miners, or 5,000,000 of the population engaged. In France the maximum would be much less, scarcely more than 30,000,000 tons. In Belgium the maximum was nearly reached at 15,000,000 or 20,000,000 tons. Though the continental production was small, he would expect the English mines, even at the high maximum of production he assumed with 250,000,000 tons, to last for eight centuries to come. [*Am. Manuf.*, 8–31.]

A Nickel Mine is reported to have been discovered near Pottsville, N. J., showing a vein three feet in thickness. —M. Meissonier reports to the French Academy of Sciences, the occurrence in Spain, in the province of Malaga, of a bed of nickel ores analogous to those of New Caledonia. The ore is a silicate of nickel free from cobalt, and from arsenic and antimony. The ore contains about 9 per cent. of nickel.

A New Nickel Ore.—Nickel, which of late is so much in demand, has been found always in the largest quantities in Sweden and Brazil, the yearly production of the two countries amounting to about 250,000 pounds. Germany also produces 50,000 to 80,000 pounds yearly.

Considering the present demand for that metal, this yield is much too small, especially since Germany has determined to replace her smaller coins of silver and copper by nickel. Much interest is therefore felt in the report of French travelers, as to a deposit of nickel in New Caledonia (Australia).

The discoverer of this new source was the French geologist, Jules Garnier, who traveled through the island on behalf of the Department of the Marine and Colonies, as far back as 1864. Concerning the samples and report sent in by him, the State Geologist of New South Wales, the American geologist, Dana, and Professor Livesidge, of Sydney, have published an article and given the new mineral the name of Garnierite. In it the nickel amounts to 16 per cent., and with other analyses as high as 19 per cent. The separation of the metal from its ore is much simpler than in the ordinary ore—known as nickel speiss.

Garnier remarks that "The serpentine, and in general all the minerals accompanying it, are covered with a beautiful green coating, which is a silicate of aluminum, nickel and magnesium. Nickel occurs so frequently in this way in the serpentine minerals of New Caledonia, that one hopes to find a new source of this exhausted metal, which in Belgium is worth 12 francs ($2.40) for every kilogramme (about 2·2 pounds)."

The kilogramme of nickel sells now not for twelve, but *forty* francs, so that it can be easily understood that the French Colonial Ministry has many petitions for the control of the mining of nickel in New Caledonia. Some of these have been accepted, as we hear of the arrival in France of the first ship load, some 500 tons, of garnierite.

If the present expectations are verified, the consumption of nickel will increase, and it will be removed from fluctuations in price, which will be established near to that of silver, whose place it takes and so much resembles.—*From the Chicagoer Handels Zeitung.*

American Steel.—When it is asserted that American steel is as good as foreign, it is customary with the enemies of the former to retort, "If American steel is as good as the foreign, why is so much of the foreign used?" This may, at first thought, appear conclusive, especially to those who are uninformed upon the subject; and indeed it would be, if price and quality were the only things that regulate the demand for the two steels. Strange as it may be to the uninitiated, these have much less influence than other things, a few of which we will consider.

1st. It should be borne in mind that "in the beginning" we depended upon the older countries for nearly all manufactured articles, and thus, at the start, we got in the *habit* of using them, and "habit is second nature."

2d. There were imperfections in our early manufactures that discouraged their use at first, and thus articles of foreign fabrication came to be looked upon as superior to domestic goods, which feeling continued long after the cause for it ceased to exist with regard to many manufactures. It is this prejudice, well founded at first, but now utterly baseless, that is the greatest hindrance to the universal use in this country of domestic steel.

3d. Nearly or quite all the early manufacturers of tools and cutlery in this country were Englishmen, and perhaps a majority of such manufacturers of to-day are of that nationality; all this is true also of their superintendents, bosses and workmen. What could be more natural than that these people should be in favor of English steel; that they should have more faith in it, and know better how to manipulate it?

4th. Even when the proprietors are satisfied of the unsurpassed quality of domestic steel, their English workmen may not know so well how to work it as they do that with which they have long been familiar, or the prejudice of their bosses may stand in the way.

5th. The prejudice of consumers, the origin and continuance of which we have already pointed out, is still a barrier, so much so, that many who use American steel cause the impression to get abroad that they use English, their products being so good that their patrons cannot detect the deception.

The foregoing are a few of the causes why all manufacturers of tools and cutlery in this country do not use American steel exclusively. Happily for the purchaser and manufacturer both, these causes are gradually but surely disappearing. They have already so far disappeared that many leading manufacturers not only now use the domestic article exclusively, but they publicly proclaim the fact. Among these we will only stop to mention Henry Disston & Son, saw manufacturers, and the Nicholson File Company, each the largest manufacturers of the kind in the world.

The fact is, domestic steel is not only as good as the foreign, but for some purposes better. It is used in the oil regions altogether now, and long ago substituted English steel at Hell Gate, where hard tests proved its great superiority for drills. English papers admit that American axes are greatly preferred by the Australians to English axes, not alone because of their better shape, but also of their greater reliability.

Having shown that American steel is better than the Englisd for axes, for saws, for files, for rock-drills, what more need be said? If tools such as these do not require good steel, we confess we do not know what tools do. [*Am. Manuf.* 8–17, 1876,]

The Hot Blast, in the Bessemer process, has been experimented upon in Zeltweg, in Styria; but the results have shown that it cannot be conveniently employed, owing to the giving way of the bottom of the converter after two operations. Further experiments in this direction will probably decide whether this difficulty can be profitably overcome.

Hardening Iron with Tungsten.—Tungsten is added to gray iron while in fusion. A very hard metal suitable for cutting tools is made with 4,077 kilos. gray iron and 28 grams. tungsten.—*American Chemist.*

CHEMISTRY, PHYSICS AND TECHNOLOGY

Two Dangerous Operations in the Manufacture of Dynamite are noticed by Sobrero, the discoverer of nitro-glycerin. One lies in the mixture of the nitro-glycerin with the infusorial earth; and the other in the pressing of this mixture into molds for cartridges. In both cases an explosion can easily occur by friction or pressure. Nobel recommends that the infusorial earth should be moistened with water, made into the form of cartridges and left to dry. When brought into the nitro-glycerin, the dried forms at once saturate themselves. [*Berg u. Hüttenm. Ztg.* xxxv, 276.]

Powder for Producing Ozone. By John L. Davis.—"In order to produce artificial ozone, Mr. Lender makes use of equal parts of peroxide of maganese, permanganate of potassium and oxalic acid. When this mixture is placed coninpact with water, ozone is quickly generated. For a room of medium size, two teaspoonfuls of this powder, placed in a dish and occasionally diluted with water, would be sufficient. The ozone develops itself; it disinfects the surrounding air without producing cough."

The attention of the writer was called to the above article as it appeared in the "Philadelphia Medical and Surgical Journal," under date of May 20th, 1876. For the purpose intended, it is certainly one of the best of the published formulas, but on account of the danger attending its manipulation, should be used with extreme caution. A prescription with these proportions was taken to an apothecary, who inadvertently used a mortar in mixing it, with the result of an immediate explosion; which would have been attended with disastrous consequences except for the smallness of the quantity employed.

In mixing these ingredients, trituration should not be used at all, but they should be cautiously mixed with a spatula in small quantities; and even then, if they should have been reduced to a *fine* powder they cannot be mixed without danger, as the mixture is liable to explode at the moment of contact.

Apothecaries who are not deficient in knowledge, are sometimes deficient in caution, and articles published in reliable journals are copied and used without hesitation, and the compounder or dispenser is brought into unlooked-for and unexpected difficulties.

The above article is written solely with a view of placing druggists and physicians on their guard in using or dispensing a dangerous compound. [*Am. Jour. Phar.* (IV), vi, 408.]

A New Source of Paper.—In the French island of Guadaloupe, paper is said to be manufactured out of the refuse of the sugar-cane, and to be in great repute for its quality, strength, fine grain, and smooth surface. [*Illustrirte Zeitung*, May 15, 1876.]

Liquid for Heating to a High Temperature.—It is often necessary to surround the pipes of heating or evaporation apparatus, and hot air apparatus, ovens, stoves, &c., with a boiling liquid at a temperature above 212° Fahr. it is also necessary to make use of water baths producing high temperatures. The liquid employed for this purpose is simply water in which sea salt has been dissolved. Oil baths, &c., are also used.

Messrs. Grimm and Corvin propose instead of these various agents, to make a solution of chloride of lime in glycerine, a solution which does not boil below 572° to 626° Fahr., and has the further advantages of never attacking metals nor congealing. [*Technologiste* i, 373.]

Experiments were made at Paris recently, before M. Baron, Director of the Electric Telegraph, on a new system for dividing the electric light. A single generator has fed with an admirable regularity not less than eighteen lamps, having each a power equal to 100 gas-jets. The effect was wonderful, and the apparatus will be tried shortly at the Lyons railway terminus. The principle is very simple, and was discovered by a working shoemaker. The current derived from a Gramme machine, slightly modified, is sent to a second machine, which rotates before forty-eight electro-magnets, four of these electro-magnets having a force sufficient to give a light equivalent to 100 gas-jets. Twelve electric lamps can be fed at any distance. By a very simple commutator any number of these twelve lamps can be grouped together, so that one, two, or more can be set in the same apparatus. Twelve working on the same point give a real burning sun. The force required for working both machines (the prime mover and the distributor) is derived from a four horse-power steam-engine. The experiments at the Lyons railway will be tried with sixteen lamps and an engine of from 6 to 7 horse-power. The light will be equal to 1,600 gas-jets. [*Nature*, xiv, 322.]

Salicylate of Potassium, according to Prof. Boettger, is a far more sensitive reagent for detecting the presence of iron than the sulpho-cyanide.

Toughened Glass.—The manufacture of the Bastie toughened glass has been recently commenced in this country. A factory has been established in Ohio, and another in Pennsylvania. The principle articles now being manufactured are lamp chimneys. The "toughening" is effected by placing the glass in a hot bath, consisting of three parts of linseed oil to one of tallow; the bath being at an average temperature of 360° F. After removal from this bath, it is immersed in a second bath of a temperature of 200° F. It is then plunged into a cold water bath, and lastly into one of benzine for the purpose of removing the oil; the glass is then dried in bran and is ready for shipment. [*Druggists' Advertiser*, i, 51.]

The statement that the Bastie, or some allied process of hardening glass, is being operated at several establishments in this country, has been extensively circulated. We have, however, not yet been able to verify the assertion.

The Electric Light has been introduced into several Belgian coal mines.

The Sulpho-Carbonates, which of late have been hopefully looked upon as an effectual remedy for the phylloxera, are now affirmed to have proved a failure in France, where their efficacy has been tested upon a large scale.

A Plan for Rendering Salted Meat more nutritious, thereby preventing scurvy, has been suggested by R. Galloway, F.C. S., which appears to be both simple and feasible. He proposes to add to the meat phosphate of potash, a constituent of which it is deprived in the process of salting.

MISCELLANEOUS.

A New Protector Against Fire.—On Tuesday evening, some experiments were made in the grounds of the Alexandra Palace with an extraordinary invention. Mr. Oersberg, a Swedish mechanician, claims to have invented, and Captain Ahlstrom, a compatriot, to have matured and fitted for practical use, a dress which will enable the wearer to dash with impunity into the fiercest fire for the purpose of saving life or property. At the east end of the palace, between the circus and the banqueting hall, huge piles of old dried wood were heaped up, intersected by narrow avenues, and the wood was drenched with petroleum. The consequence was, that the moment a light was applied to the pyre the whole blazed up with a flame so fierce, and sending forth a heat so intense, that the thousands who had gathered around to witness the scene were forced to retire to a more respectful distance. The sun's rays, which had hitherto been inconveniently felt from above, were quite forgotten in the glow which now flamed up from below, and it really seemed as if there was malice in the tongues of the fire that spat out on every current of passing air. Standing 40 yards to the windward of this fierce fire, the heat was all but intolerable, and even the firemen of the Palace brigade, under the command of Captain Archer, the chief officer, were fain to give a wide berth to the burning centre. Then it was that Captain Ahlstrom, clad in a dress not at all unlike that worn by Captain Boynton when he paddled himself across the Straits of Dover, made his appearance on the scene. His costume consisted, so far as it was possible to ascertain, of an overcoat of fustian, covering an inner garment of wool and felt. Between the two skins—so to say—is a network of veins, through which are pumped continuous supplies of air and water, the main air-tube before it reaches the body being enclosed in the large water-tube, and by such means kept perfectly cool. The escape for the cool air is through orifices in front of the face, and the current so made forces back the flames, and leaves perfect breathing space. Assurance was given that the clothing itself is in no way chemically prepared, and is simply protected against the action of the flames by the torrents of water that pour over the man from head to foot. With the greatest possible nonchalance Captain Ahlstrom walked into and through the fiery furnace, not only free from discomfort, but apparently with enjoyment. After spending about ten minutes in about the warmest climate it is possible to imagine, enveloped so as at times to be hidden by flames, he carried out a chair which was on fire, sat cooly down upon it, and to the amusement and astonishment of the spectators, smoked a cigar. [*Iron*, viii, 202.]

—The N. Y. *Herald* says that the Croton reservoirs are merely catch basins for the filth of the country, and that the surface water will have to be shut off or else the Croton basin depopulated in order to preserve the purity of the water supply.

Petroleum in Europe.—According to the estimate of M. C. Foucault, the country of Roumania alone could furnish sufficient petroleum for the consumption of the whole of Europe. In his exploration of the valley of the Danube he has ascertained the existence of numerous springs, the produce of which ought to be considerable. At present the total yearly export of petroleum from Roumania does not amount to more than £40,000, for want of enterprise and capital. [*Moniteur Industriel Belge*, July 10, 1876.]

Pittsburgh's Industrial Exposition.—The second annual exposition of the Tradesmen's Industrial Institute opened on Saturday, the 19th of August, the time having been postponed from Wednesday, on account of the tardiness of exhibitors.

There have been many improvements made in the buildings since last year, and a new structure, Floral Hall, added. The interior of Main Hall has been beautifully kalsomined, which adds very much to its appearance, and various other improvements calculated to add to the convenience and comfort of visitors have been made. We have been informed that all the space down stairs and nearly all up stairs has been engaged. There is a great deal more space in this department for exhibits than there was last year, as the floral exhibits will this year be in a separate building—Floral Hall.

The Art Gallery, which was such an attractive feature last year, will contain a still larger and more handsome collection this year, many of the paintings being from the East and from Europe.

Floral Hall, 125 by 175 feet, when the interior is fully completed, which will be in a few days, will be the most inviting spot in the entire buildings. Here will be rare flowers and plants, a fountain, a miniature lake, a cascade, and meandering walks—the whole brilliantly lighted with gas, reflected by several of the Bailey reflectors, a valuable Pittsburgh invention.

Machinery Hall is filling up, and will soon be a place of no small interest, especially to those more directly interested in machinery. The power will be furnished by an Alden patent triple-cylinder engine, manufactured by Robinson, Rea & Co., and an engine made by Thos. Carlin & Sons.

The time for the admission of exhibits has been extended to September 1st and the time for closing the exhibition has been lengthened to the 25th, and possibly to the 1st of October. [*Am. Manuf.*, Aug. 24th.]

—At the present rate of consumption, it is estimated, the forests of the United States will hold out but seventy years longer, if nothing is done to renew the same by cultivation.

—The funds of the Smithsonian Institution now amount to $717,000. It is calculated to authorize a series of experiments to determine with accuracy the rate of increase of the earth's temperature at progressive depths. Other suggested investigations include new and careful experiments on the velocity of light, and the re-determination of the earth's density by the method of Cavendish.

Steel for Ships of War.—Another step in advance in ship building has been taken by the introduction of steel for the hulls of war ships, by which a great diminution in weight, and a consequent increase in speed will be gained. The firm of Elder & Co., of Glasgow, has received a contract for the building of six vessels of this new build. They are to be corvettes of 2300 tons and will carry fourteen guns. The steel hull will be sheathed with two thicknesses of teak, and coppered externally. [*Iron*, viii, 227.]

There were 1019 *patents*, 47 re-issues, and 50 designs issued, and 57 trade-marks, and 27 labels registered by the United States Patent Office during the month of July. —*Kreosozone*, a new substance for the preservation of animal substances, has been very successfully employed in Germany, for the preservation of meat of various kinds, and of anatomical preparations.

Solar Heat and Sun-Spots.—The present season has been extraordinary in many respects, but the intensity of heat in July and August has signalized it as quite without a parallel in meteorological records. The heat has been intense, not only in all parts of our country, but in Europe as well. The absence of sun-spots, which has been noticed since the last week in March, may have some bearing upon this excessive evolution of solar heat. If large areas of the sun's disk, which are usually to some extent eclipsed, have this season been constantly luminous, it would appear plausible to connect sun-spots with solar energy and with range of temperatures upon our planet. They have not, however, we believe, been regarded as capable of producing planetary disturbances of this kind. But we know that the nature of these spots is quite imperfectly understood, and although great light and heat energy exists in all parts of them, even in the darkest, still this may not prove that they have no cooling influence.

A long series of careful observations can alone settle this point, a series much more extended than any yet undertaken. The immense activity at present in the study of solar physics will undoubtedly soon greatly enlarge our knowledge upon the possible connection which may exist between terrestrial heat and sun-spots. [*Bost. Jour. of Chem.*, ix, 297.]

—The introduction into India of the South American rubber-producing tree is a matter of much interest, not only to England, but to all the world. The supply from Para and other parts of South America is not equal to the demand, and the time is not far distant when the prices of rubber fabrics must be greatly enhanced unless it can be successfully cultivated in the eastern hemisphere. The experiments in India have not been apparently successful, and it is still a matter of doubt if the soil and climate are adapted to its cultivation. [*Bost. Jour. of Chem.*, ix, 32.]

Upon Lightning Rods.—Dr. Mann read a paper at the Science Conference at South Kensington, whose purpose was to show how unimportant is the form of lightning conductors, whether rods, ropes or pipes; and that the real desideratum is that they shall be of sufficient size to afford an unobstructed path for the passage of the electric fluid. He insisted on the necessity of a goodly number of points, and above all upon the indispensability of large earth contact, saying that a lightning discharge passing through a large rod with an ample earth contact, is only a gentle stream of low tension; but that, if the size of the rod or the area of its contact with the earth is diminished, the tension is increased, and the fluid has a dangerous tendency to discharge itself laterally by chance outlets. [*Jour. of Telegraph* ix, 261.]

Decolorizing Properties of Ozone.—M. Boillot ascribes the bleaching effects, heretofore credited to chlorine, as being really due to ozone. Ozone, employed directly, acts as an oxidizing agent, laying hold of the hydrogen of the substance with which it is in contact, and bleaching it if the body is colored. The action of chlorine the author explains as follows: On allowing chlorine to act upon any animal or vegetable matter, it decomposes a certain quantity of water, and seizes its hydrogen, forming hydraulic acid. The oxygen set free by this action is transformed into ozone, which in its turn lays hold of the hydrogen of the organic matter.—*Harper's Annual Record*, 1875.

Coal in the Strait of Magellan.—An important discovery, if correctly represented, has lately been made in the opening of a rich coal-mine in the southern part of Patagonia, near Brunswick Island, in the Strait of Magellan, in the locality known as Captain Corey's Ranch. near the Chilian colony of Punta Arenas, in latitude 53° 9′ S. and longitude 73° 13′ W. The property referred to has been granted by the Chilian government to three French explorers, Messrs. Bouquet, Derue, and Suzainecourt. There are three distinct beds of the coal, of which one is about 300 feet above the level of the sea, of a minimum thickness of about 6½ feet. The second is from five to six feet in thickness, and is about 170 feet above the first. The third is about 130 feet above the second, with a thickness of 16 feet, divided into three nearly square layers, and separated by thin strata of slate. In view of the large number of steam-vessels annually traversing the Strait of Magellan, an unlimited supply of good coal in that locolity is a matter of very great importance.—*Harper's Annual Record*, 1875.

—An English journal remarks that thunder-storms are yearly becoming less and less frequent in the neighborhood of London, and attributes this fact to the purification of the Thames and the improved drainage of the city. It adds that the course of the most violent thunder-storms follows the line of polluted rivers, stagnant ponds, swampy grounds, and badly drained towns.

Practical Engineering. A peculiar work has been completed by the Ches. & Ohio Canal Company to make a new outlet from the canal to the Potomac. The elevation to be overcome is forty feet, which under the old system would require eight locks and nearly an hour's time for the passage. The new arrangement is the employment of a large caisson, or tank, filled with water, into which the boat is floated, when the caisson, with its load of water and boat, is run down the incline on rails in less than six minutes. The weight of the loaded caisson is about 350 tons. The first expense of constructing locks and the constant expense of operating them and keeping them in repair is saved, as well as the time. [*Railway Review*, xiii, 69.]

IMPORTANT PAPERS, too long to reproduce in our columns.

ON THE DETERMINATION OF CARBON IN IRON. *Berg-u Hüttenmännische Zeitung.* Trans. in *American Chemist.*

COMPUTATION OF EARTHWORK. By Prof. E. W. Hyde, A. M. In *Van Nostrand*, Sept.

BIBLIOGRAPHICAL NOTICE

THE COMPLETE PRACTICAL MACHINIST; Embracing Lathe Work, Vise Work, Drills and Drilling, Taps and Dies, Hardening and Tempering, the Making and Use of Tools, etc., etc. By Joshua Rose. Illustrated by 130 engravings. Philadelphia, H. C. Baird & Co., 376 pp, 12mo., cloth; price, $2.50, including postage.

This long-expected work by so able and practical a writer as Mr. Rose, consists substantially of the author's contributions, during the past two years, to American and foreign periodicals; but we now have the subject treated more fully, while a large quantity of new matter has been added.

The aim of the work is "to develope from the promiscuous practice of the workshop its inherent science; and to present it to the mechanic so arranged that he will find each formula the natural sequence to its predecessor; and while explaining its positive conditions, to so present its negative ones that the mind will instinctively seek the remedy which its successor will supply."

The book is a very valuable contribution to the literature of the workshop; and its complete index of subjects gives it an encyclopedic value. We shall show our practical appreciation of the value of the work by drawing largely from such of its contents as have not heretofore met the public eye; but we commend it heartily to every mechanic and practical man, as worth very many times the money that it costs; and giving the young mechanic in particular the advantage of years of other men's keen observation and valuable experience.'

We should say, in this connection, that Mr. Rose has been engaged to contribute regularly to the columns of the POLYTECHNIC REVIEW. G.

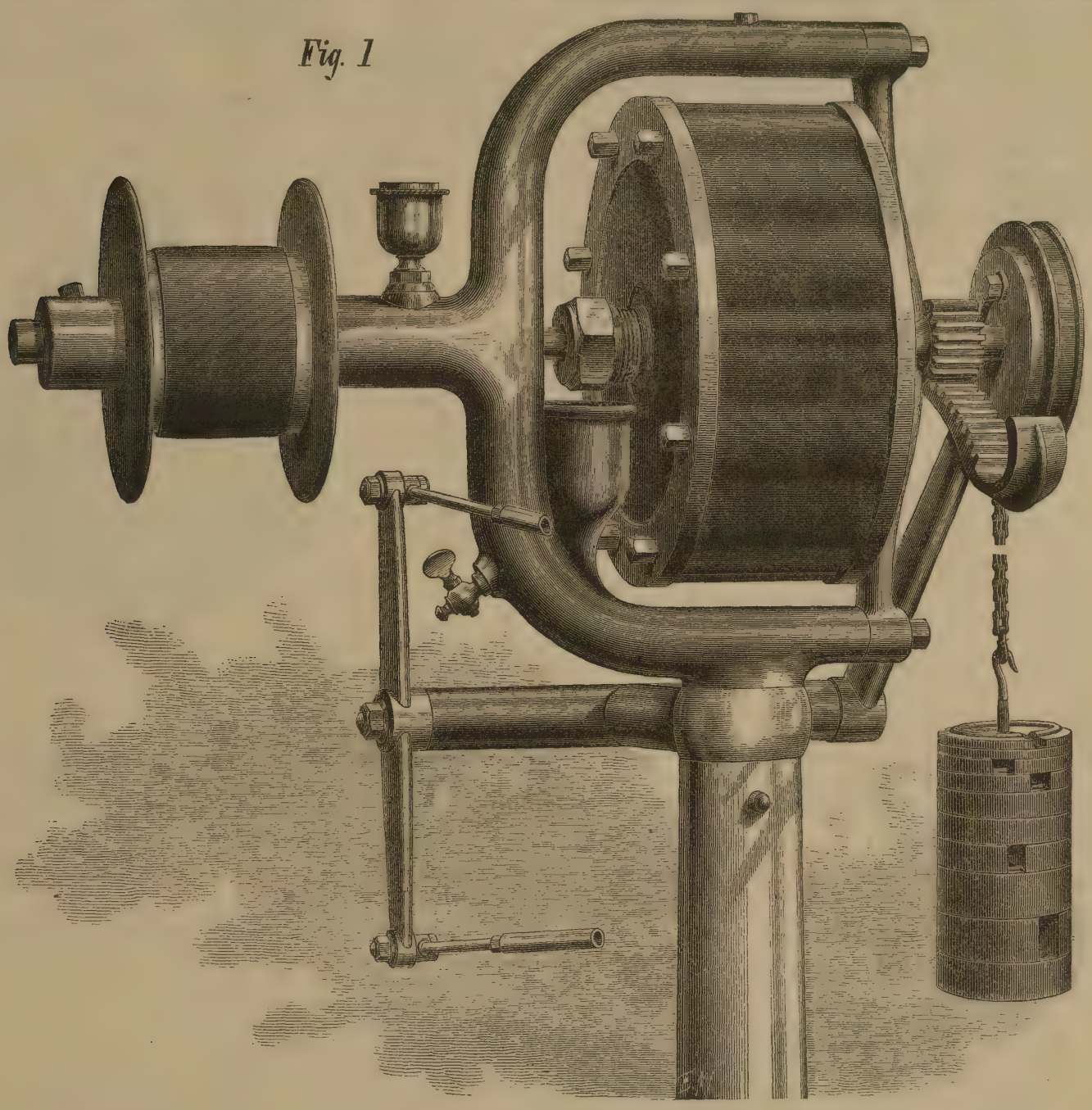
THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, SEPTEMBER 16, 1876. NO. 11.

Fig. 1



THE "ALLEN" GOVERNOR.

The "Allen" Governor, from its peculiar construction and action, is attracting considerable notice at the Centennial Exhibition; and as it is radically different from all other forms of governor, merits a special mention.

The centrifugal principle which is almost universally used in other governors is here replaced by a very novel as well as sensitive and powerful contrivance to be hereafter described.

The accompanying engravings illustrate very clearly its general appearance and mode of action: Fig. 1 showing a perspective elevation, Fig. 2 a vertical section through the axis, and Fig. 3 in the plane of rotation.

The corrugated cylinder, A, Figs. 1 and 2, is filled to about two-thirds of its capacity with oil. On the inside, at the ends and on the periphery, are eight ribs, and between them intermediate ones on the periphery only.

Inside of this cylinder is the paddle wheel, B, having six blades, and which, as shown in Fig. 2, has but slight clearance in passing the ribs. The shaft or spindle of the paddle-wheel passes through a stuffing-box, and a journal bearing in the housing or frame, and carries the flanged pulley, shown in Fig. 1. Into the other head of the cylinder is screwed a stud which forms the journal for that end, and carries the pinion, D, which gears into, and gives motion to, the segment, E. Outside of the pinion is the scroll wheel, C, over which passes the flat link chain, carrying the weights shown in Fig. 1.

The segment, E, vibrates the rock-shaft, to which is attached a short arm for lifting the valve, where the governor is of the throttle form. When the governor is to be applied directly to the cut-off, the long arms in Fig. 1 are used.

As will be seen by examination, the governor is capable of giving great power in operating the valve or cut-off, as will be demonstrated hereafter.

The action is as follows: The flanged pulley being driven by belt from the main shaft of the engine, revolves the paddle-wheel, B. As the oil in the cylinder offers a resistance to this motion, from being held by the ribs, the tendency is to carry the cylinder around with it. The weighted chain on the wheel, C, prevents this until the velocity of the paddle-wheel has reached such a point that the friction or resistance offered by the oil overcomes the inertia of the weight, when the cylinder also begins to revolve, and the pinion, D, moving the segment, E, closes the valve, and the speed is reduced, when the weights again bring the cylinder back to its original position. The operation is very quick, as may be demonstrated as follows: The paddle-wheel, making about two hundred revolutions per minute, will not revolve the cylinder, as the friction of the oil is not sufficient to overcome the resistance of the weight: but an increase of a very few revolutions on the speed of the paddles will instantly move the cylinder *at nearly the same velocity*. Now, as the slightest motion of the cylinder is imparted to the valve, and as about two revolutions of the former will entirely close the latter, it is evident that the slightest increase of speed of the engine must cause the prompt closing of the valve.

The power which the governor is capable of developing may be thus demonstrated: Let P represent the power received from the resistance of the oil to the motion of the paddles; D the radius of the pinion; E of the segment; R the rock-shaft arm; W the resistance offered by the valve; C the radius of the cylinder—then

$$P \times (C-D) \times (E-R) = W.$$

Take, for illustration, a cylinder 8 inches diam., with a pinion (B) 1 inch diam., radius of segment (E) 12 inches to pitch line of teeth; rock-shaft arm for raising valve 1 inch, power transmitted to cylinder 15 lbs., then $15 \times (4-.5) \times (12-1) = 577.5$ lbs.

Fig. 2

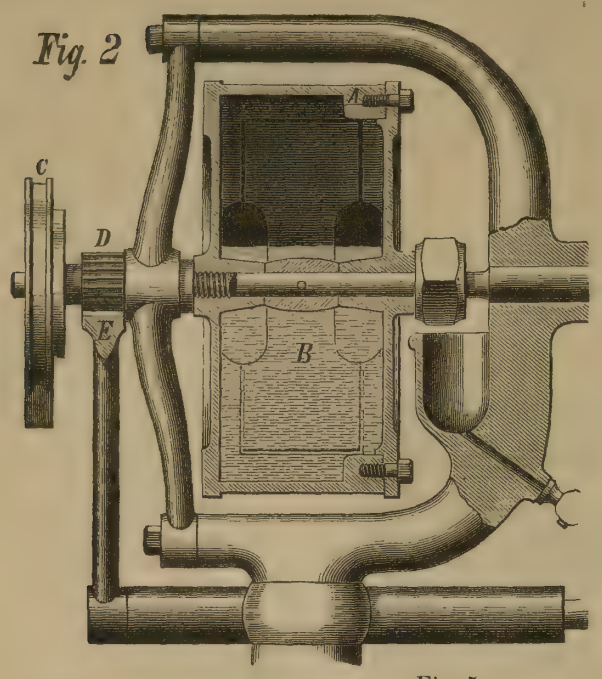


Fig. 4.

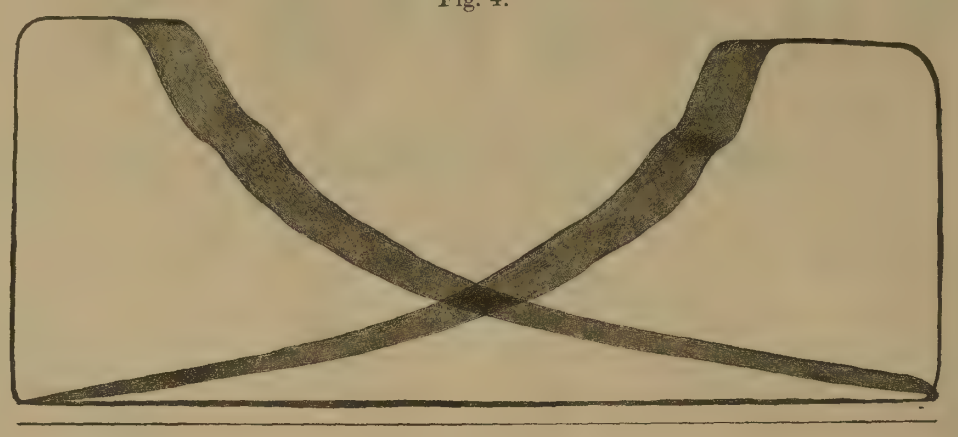


Fig. 5.

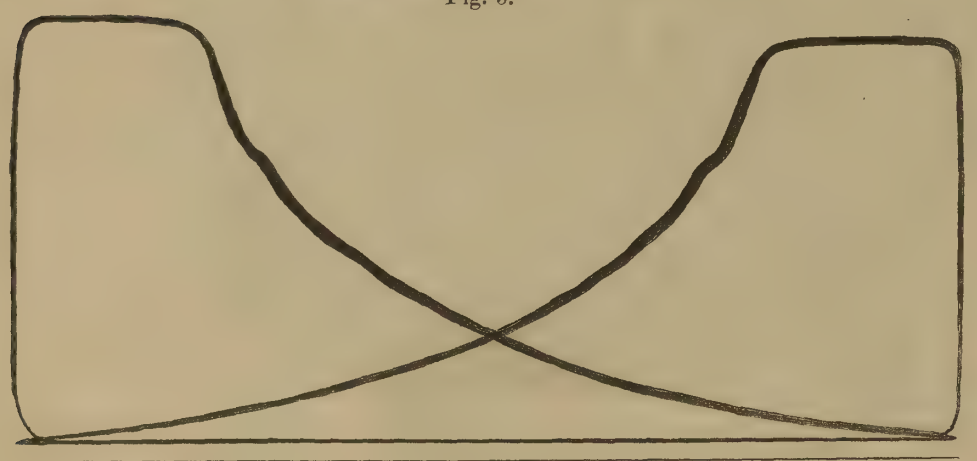
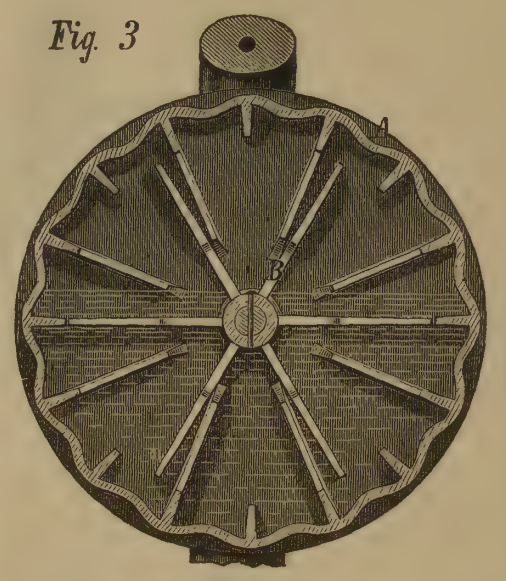


Fig. 3



actual power applied to valve. A reference to the cuts of indicator diagrams, taken from a 16×60 variable cut-off engine *with the same regulator*, shows the comparison in uniformity of action, between the Allen Governor and the one which it replaced—Fig. 4 being the latter, and Fig. 5 the former. Even to those to whom the theory of the indicator is an enigma, the variation of the point of cut-off, in each case, during the full minute in which the pencil was in contact with the card, is apparent, as the parabolic curve being the expansion line of the steam, shows the points at which the valve closed at each stroke of the piston.

The workmanship on this governor is good, the manufacture being superintended by the inventor, Mr. R. K. Huntoon, and the absence of springs and joints, and all bearings subjected to rapid wear, makes it very durable and unlikely to get out of order.

The drip-cup under the stuffing-box receives all leakage from the cylinder, and it may be drawn off by the cock in the bottom.

The enormous power developed, renders this governor peculiarly adapted for slide valve cut-offs; and as it may be placed in any position without impairing its action, it makes an excellent governor for marine engines, and for the same reasons it may be applied equally well to turbine water-wheels.

The manufacturer, Mr. Stillman B. Allen, of Boston, states that he will furnish information to parties interested, even if they do not wish to purchase. B. F. T.

NOVELTIES OF THE EXHIBITION.

VULCANIZED FIBRE.

It has long been known to chemists and practical men that cellulose or woody fibre is peculiarly susceptible to the action of certain chemical reagents, and a great variety of ingenious processes have been devised for utilizing the fact. Of the numerous products obtained from the substance in question, the general public is perhaps best familiar with parchment paper, and nitro-cellulose or gun-cotton. Immensely valuable, however, as the products above named have become in the arts, their value will most likely be vastly eclipsed by that of certain products obtained by the treatment of vegetable fibre with certain metallic salts, whereby the same is converted into a substance tough, leathery, and unchangeable, hard or flexible, as may be desired, and susceptible of so many and various uses as a substitute for leather, wood, rubber, and metal, that their enumeration would be tedious. Visitors to the Exhibition may find it of interest, therefore, to examine several excellent displays of a variety of manufactured articles made of vegetable fibre subjected to chemical treatment as before alluded to. These products and goods are exhibited by the Vulcanized Fibre Company. Its display is made in two locations. In Machinery Hall is shown a number of samples of the products known as hard and flexible vulcanized fibre, and a variety of articles manufactured therefrom and adapted for general mechanical purposes, &c.; while in the Shoe and Leather Building there is shown a number of trunks, valises, etc., made therefrom.

The claims of the makers of these highly interesting products will perhaps be more fairly presented to the readers of the "REVIEW" by following the descriptive pamphlet issued by the company, in which they are set forth in detail.

From this publication it appears that vulcanized fibre is an entirely new article of manufacture, consisting of vegetable fibre reduced to a pulp, and then subjected to powerful chemical treatment, whereby the original properties of the fibre are entirely changed, and a new and exceedingly valuable material is produced, which is already largely utilized, and will eventually enter into almost every branch of mechanical industry. The process and different articles made are secured by numerous patents, but the goods are sold at less prices than any competing articles, and in most cases are superior to anything of a similar nature ever offered. They are made either hard or flexible, as desired, varying in their properties to some extent, according to the uses for which they are intended.

The hard fibre is somewhat like horn in its consistency, is very tough and strong, has remarkable durability under friction, and remains permanently elastic under all ordinary conditions of weather and temperature.

The flexible fibre closely resembles the best English sole leather in appearance, and is largely used as a substitute therefor in mechanical appliances, but is much closer grained and far more durable, and being of uniform quality and thickness throughout, cuts without waste. It is used largely in place of rubber for packing.

The general exhibit in Machinery Hall includes a number of miscellaneous articles, such as napkin rings, martingale rings, tobacco boxes, condenser ferrules, etc., gas and pneumatic conductors, besides a number of articles adapted for general mechanical uses, such as elastic fish-bolt washers, car-box covers, and dust guards, gibs and journal bearings, plumbers' and axle washers, flexible sheet packing, etc., etc.

Concerning the valuable properties of these articles, it is repsesented that the vulcanized fibre is perfectly insoluble in hot or cold water, oil, naphtha, petroleum, or alcohol, and but slightly affected by most of the acids. It will not absorb oil nor any other fluid except water, and the only effect of water upon it is to cause it to expand and become elastic like leather. For washers in various situations, the vulcanized fibre is affirmed to be at once cheaper than leather and far superior to it in durability, because of its indifference to many agents that speedily rot the latter and render it useless. These washers are said to be rapidly growing in favor, for mechanical, railroad and general machine uses, for which purposes the company supplies the goods cut to order, of any desired pattern or thickness, or furnishes those who desire to cut their own washers with the material in sheets of any thickness. For gibs for crossheads, etc., the manufacturers furnish hard-rolled goods of suitable length and width, which they assert will be found to be cheaper and more durable than brass, not liable to cut the slides, and very economical of oil.

Being entirely free from grit, and having remarkable anti-friction properties, the vulcanized fibre is further claimed to be well adapted for journal bearings, where there is high speed without too great weight, such as shafting, and other bearings up to two inches in diameter. In these positions it will greatly outwear brass or Babbitt metal, and require only one-half the usual lubrication. It is usually applied in the form of a tube for bearings from $\frac{3}{8}$ in. to $1\frac{1}{2}$ in. diameter; and above that size is used in plates $\frac{1}{8}$ in. to $\frac{1}{4}$ in. thick, set edgewise in a brass or iron box, and bored out. The spaces between the plates form receptacles for the oil, which thus renders the bearing self-lubricating for a long time. The tubes are furnished in all sizes from $\frac{3}{8}$ in. inside diameter

up to 1⅛ in. in any desired lengths up to 22 inches, the price being from 4c. to 10c. per lineal inch, according to size. These tubes are rolled accurately true, both inside and outside, and need only to be cut off in proper lengths, and clamped between iron boxes, or caps, to be ready for use.

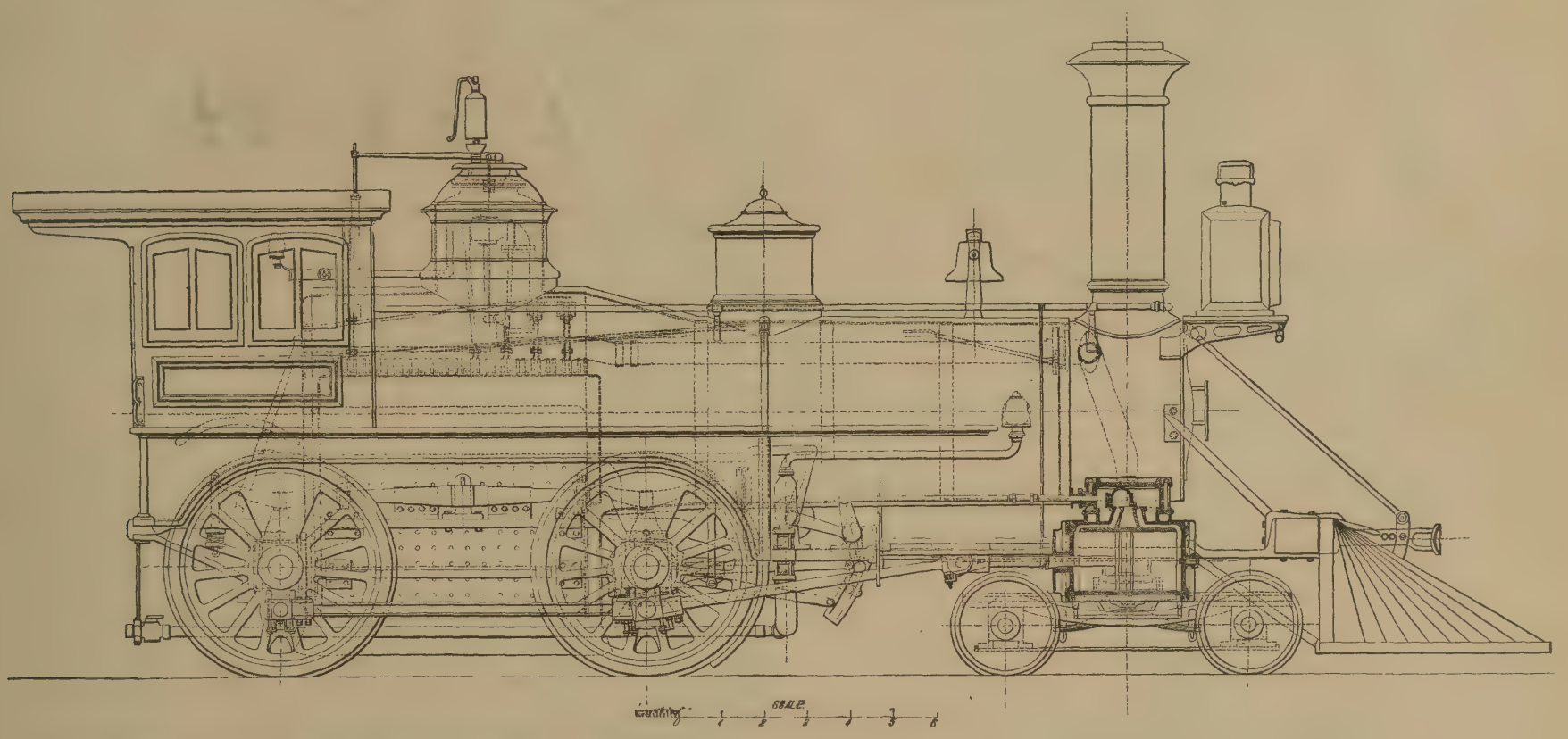
Concerning the flexible sheet fibre, the circular of the company affords the information that "the sheets are made 42 in. wide x 5 ft. 6 in. long, and of any desired thickness from 1-32 in. to 9-16 in., but are usually cut into half-sheets 21 in. wide x 5 ft. 6 in. long for convenience of shipment. These goods are used for carriage washers, gaskets, water packing, plumbers' fittings, car-box washers (or "dust guards,") oil box covers, and a great variety of uses. They are more easily and accurately cut than leather, and being uniform in quality and thickness throughout, there is no waste in cutting, like that which occurs from the "skirts and flanks" of sides of leather. They are insoluble in and uninjured by hot or cold water, oil, grease, petroleum, gas, turpentine, alcohol, or any of the ordinary solvents, and do not apparently deteriorate by age. While not in all cases a substitute for leather or rubber, in mechanical uses, they are in many positions far superior to either of these articles, and as experience determines the places to which they are specially adapted, they supersede all competing goods for such uses. An immense trade is already done with axle makers, carriage factories, and livery stables, for carriage axle washers; with railroads and car manufacturers, for car box washers and oil box covers; with plumbers and faucet makers for water packings of various kinds; and also with water companies, pump makers, etc., for fire hydrants, pumps, etc.

Owing to the great strength, elasticity, durability, and lightness of hard vulcanized fibre, it is remarkably adapted for the manufacture of trunks, valises, etc., particularly such as are heavily packed and subjected to hard usage, such as express package trunks, travelers' sample cases, plate chests, paymasters' money trunks, etc., as well as the ordinary "Saratogas," and dress trunks.

The Company, according to statement, is about entering into the manufacture of these articles on an entensive scale; and declares its ability to produce a class of goods lighter, cheaper, stronger, and more durable than anything now made, and equally as handsome. In this connection the Company's exhibit of trunks and valises in the Shoe and Leather Building will be found of interest to inspect.

Several very important fields of usefulness for this hard fibre have recently been developed, chief of which in magnitude is its application to shoe-making—for tips, counters, shanks, box toes, insoles, and shoe-pegs—for all of which it seems admirably adapted. This subject is exciting great interest in Massachusetts, and promises to work a revolution in certain branches of shoe making. It is also well adapted for harness loops, and some of the mountings; baggage checks, electrical instruments, etc. It is used successfully for insulating railroad tracks and joints, for Robinson's system of wireless automatic electric signals, which are in use on the Boston and Providence, and Boston, Lowell and Nashua railroads.

The manufactory of the Company is located at Wilmington, Del., and the New York office at 17 Dey St. Visitors to the Exhibition will find the product and miscellaneous goods exhibited in Machinery Hall at section D, No. 9, post 65; and the display of trunks and valises at the rear end of the Shoe and Leather Building, section G, No. 1, class 285. W.



CENTENNIAL EXHIBIT OF BALDWIN LOCOMOTIVE WORKS.

V.

PASSENGER LOCOMOTIVE, "AMERICAN" PATTERN.

For the Pennsylvania Railroad Company. Constructed in accordance with drawings furnished by the Company. (Pennsylvania Railroad Company's "Class C.") Gauge, 4 feet 9 inches. Fuel, Bituminous Coal.

LOCATION: SECTION E 6, COLUMNS 41–42.

CYLINDERS.

Diameter	1 ft.	5	inches.
Stroke of piston	2 ft.		
Length of steam-ports	1 ft.	4	"
Width of steam-ports		1¼	"
Width of exhaust-ports		2⅓	"
Travel of valve		5	"
Outside lap of valves		¾	"
Inside lap of valves		none.	

Exhaust nozzles—double.

WHEELS.

Diameter of driving-wheels	5 ft.	2	"
Diameter of truck-wheels	2 ft.	4	"
Distance between centres of front and rear driving-wheels	8 ft.	6	
Total wheel-base of locomotive	22 ft.	5⅝	"
Total wheel-base of locomotive and tender	44 ft.	3⅛	"
Diameter of driving-axle journals		7	"
Length of driving-axle journals		7½	"
Diameter of main crank-pin bearing		3¾	"
Length of main crank-pin bearing		3¾	"

BOILER.

Outside diameter of smallest ring of boiler	4 ft.	1⅜	"
Thickness of boiler plates (steel)		5/16	"
Number of tubes	155		
Length of tubes	10 ft.	8	"
Outside diameter of tubes		2¼	"
Length of fire-box inside	6 ft.	⅝	"
Width of fire-box inside	2 ft.	10⅞	"
Depth of fire-box inside	5 ft.	7	
Thickness of flue-sheet		½	"
Thickness of sides, back and crown-sheet		5/16	"
Square feet of grate surface	18		
Square feet of heating surface in fire-box	106		
Square feet of heating surface in tubes	971		
Total square feet of heating surface	1077		

TENDER.

Number of wheels	8		
Diameter of wheels	2 ft.	9	"
Diameter of tender-axle journals		3¼	"
Length of tender-axle journals		7	"
Capacity of tank	2400 gallons.		

WEIGHT.

Weight of engine in working order	71,300 pounds.
Weight of engine on driving-wheels	45,800 "
Weight of tender, empty	22,000 "

MATERIALS.

Boiler, Bay State Iron Co.'s Homogeneous Cast Steel; *Fire-Box*, Park, Bro. & Co.'s Homogeneous Cast Steel; *Tires*, Standard Steel Works' Crucible Cast Steel; *Engine Truck- and Tender-Wheels*, A. Whitney & Sons' Chilled Wheels; *Flues*, Morris, Tasker & Co.'s Lap-Welded Charcoal Iron Boiler Tubes; *Injector*, William Sellers & Co.; *Steam-Gauge*, H. Belfield & Co.'s; *Brass and Copper Piping*, American Tube Works; *Tank Iron*, Abbott Iron Co.; *Jacket Iron*, W. D. Wood & Co's Patent Planished Sheet-Iron; *Head-Light*, Pennsylvania Railroad Co.; *Air-Brake*, Westinghouse Air-Brake Co.

[*To be continued*]

BACK NUMBERS WANTED.—In consequence of the great demand for back numbers of the REVIEW, to complete sets for subscribers, we are obliged to advertise for copies of No. 1, of Vol. I, and of Nos. 2 and 4 of the current volume, for which the retail price will be paid.

CUSHION-SEATED VALVE.

A check-valve is of prime necessity in all piston and plunger pumps, and is associated among the earliest inventions in this class of hydraulic machinery. Its performance should be one of the simplest of operations, but is of such importance as cannot be dispensed with. Like other pieces of mechanism the check-valve has its defects, prominent among which is its sudden closing under high pressure, arresting too quickly a heavy moving column of fluid, creating a "water hammer" that exerts a destructive force that rebounds throughout the entire pumping machinery and the pipes connecting therewith. This has at once a tendency to damage the pumps, engines and pipes, and creates a nuisance by a constant pounding noise that is particulary grating to an engineer who loves smooth machinery.

Shaw's Cushion-Seated Valve, shown in the annexed engravings, is designed to obviate the many difficulties that beset the ordinary valve, and to that end is con-

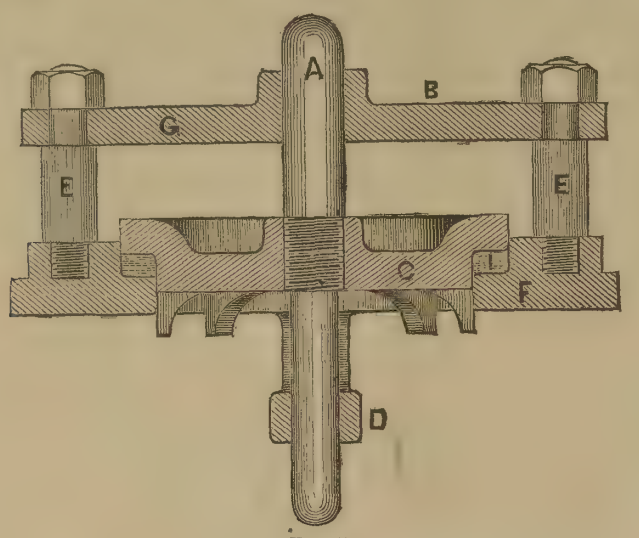


Fig. I.

structed to form a cushion in all the area of the valve-seat, by confining a portion of the material pumped in a space provided especially for that purpose.

On reference to the cuts, Fig. 1 is a vertical section through the centre of the valve-seat, &c., and Fig. 2 is a transverse view of the same, of which F is the valve-seat, having on its under side a guide, D, for the valve-stem A, and at its upper side a guide rib B secured to post, E. The valve C is secured to the valve-stem A, to insure its concentric position in this form of valve; and it is provided with the important and improved feature of a plunger or piston-head projecting above and below its face, from ¼ to ½ inch, according to size of valve.

There is also a corresponding recess in the seat of the valve, as shown in the cuts; Fig. 1 showing the valve closed, and Fig. 2 open. This construction causes the fluid

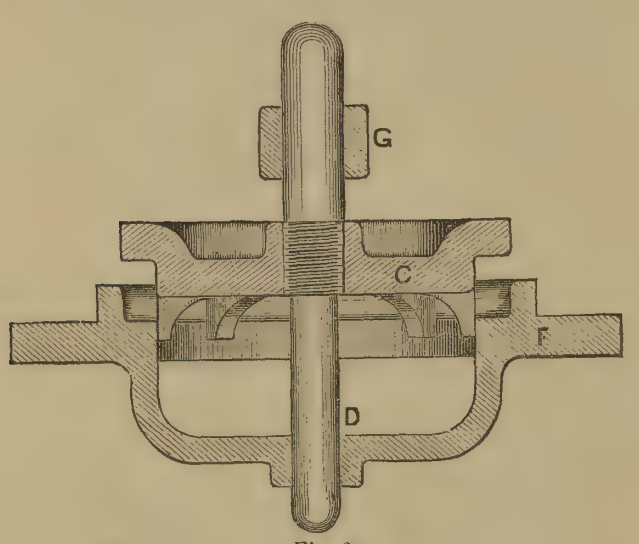


Fig. 2.

or material pumped to be imprisoned in the entire area of the valve-face, as shown at I in Fig. 1. This imprisoned fluid makes a dash-pot of all the area of the valve-face, and it is upon the imprisoned fluid contained therein that the valve comes to a gentle rest, moving slowly towards the metallic seat as the fluid slowly escapes around the plunger heads. As it is intended that the fluid shall escape from the seat of the valve, a tight fit is not necessary in the plunger heads. The confined fluid is renewed at every stroke without expense, and the face of the valve is protected from the severe wear that soon causes ordinary valves to leak and give out. This improvement is applicable to every class of check valve for all purposes, and to all modification of valves, including the double beat Cornish valve. As a cut-off valve for steam, it dispenses with the outside dash-pot, and has this advantage over a valve provided with an outside dash-pot, that it shuts off the steam the instant it cushions, whereas that with a separate dash-pot, blow through so long as the valve is cushioned on the dash-pot; the valve being held open for that lenghth of time.

For futher information pertaining to the application of these valves to pumps and engines, the reader is referred to the patentee, Mr. Thomas Shaw, 915 Ridge Avenue, Philadelphia.

A LOCOMOTIVE engine, fitted with the patent apparatus manufactured by the Handyside Steep Gradient Company, of Bristol, is now working both passenger and goods traffic for the London and North-Western Railway Company on the Hopton incline of the High Peak Railway, Derbyshire. The incline on that railway is one in fourteen. [*The Engineer*, xlii, 135.]

FIRE PROTECTION.

PROTECTION OF OIL TANKS FROM LIGHTNING.

I.

The frequent destruction, by lightning, of the huge iron tanks largely employed in the oil regions of this and adjacent States, for the storage of petroleum, is a matter of such importance as to call for the most careful consideration, in order that, if possible, the causes of these disasters may be correctly ascertained, and the most effectual remedies applied.

In order to have a proper comprehension of the conditions of the problem to be solved, it will be well to introduce the subject by giving a brief description of the manner in which these tanks are constructed. Upon this point, the writer is fortunate in having at hand an interesting discussion of the subject under consideration by Mr. Wm. S. Newell, from whose very complete notes the following extract is made:

"CONSTRUCTION OF IRON TANKS.—Storage tanks, whether built by private enterprise or constructed in the interests of the 'Pipe Lines,' are necessarily of iron. They must needs be of some such material in order to resist the pressure of enormous quantities of fluid intended to be stored within them. Their contents vary all the way from 8,000 or 9,000 to 25,000 bbls. of 42 gallons each.

These tanks are constructed of heavy iron riveted together and made fluid-tight in the usual boiler fashion. The first step, after the bed has been made by carefully compacting and leveling the ground on which the tank will rest, is to lay out the sheets which are to constitute the bottom on wooden horses properly arranged in the bed. These bottoms are then riveted together until a vast iron disc of the required diameter is produced; the diameter in the case of a 20,000 bbl. tank, for instance, being about 80 feet. It is calculated in a rough way that the bottom of the tank with the first ring of siding attached, is chargeable with half the cost of the whole tank. This first ring is attached to the bottom by means of a number of L shaped pieces to which these parts are respectively riveted. The remaining rings are attached or built up in the usual boiler fashion. At the proper time the wooden bases are withdrawn, and by means of jack-screws or some similar device, the tank is let down upon its earthen bed.

"The roof is either of iron or of wood. Iron roofs are sometimes constructed of something akin to ordinary roofing metal, properly supported by a frame within, if the tank be small; but if it be large, the roof is generally constructed of heavier sheets, riveted together. The vast majority of tanks have wooden roofs. Out of 85 examined by me, only 18 had iron tops. Wooden roofs are generally tarred and graveled. Sometimes, instead of being flush with the top of the tank, they are set some inches below it, forming a 'water-top,' intended to hold water. Sometimes they are covered with earth, in which, vagrant grass seeds taking root, the roof presents somewhat the appearance of turf. These are the 'earth-tops.'

"Every roof has a 'man-hole,' generally upon the principle of an ordinary house scuttle. It affords access to the interior of the tank for cleansing and other purposes. There is a supply-pipe which runs up the side of the tank and enters at the top, near the man-hole. About an inch or so above the bottom one or more drawing-off pipes are inserted. Access to the roof is secured by a wooden ladder or steps; these are generally permanent attachments. Across the roof, be it of wood or iron, a slatted or cleated wooden walk is provided, so that the roof may not be injured by being trodden upon. Sometimes, if tanks are near together, their roofs are connected by wooden bridges or plank ways, that easy access may be had to all.

"Sometimes the base of a tank is earthed up for three or four feet with sloping banks of gravel. Sometimes a trench a couple of feet in depth is dug about the base, with an opening towards the downward slope of land.

"When the tank is completed it is subjected to a hydraulic test; water to its full capacity is pumped in, and if the tank bears this strain without either bursting or leaking, it will of course withstand the pressure of an equal quantity of oil. Occasionally the water pressure proves too strong, particularly if the iron has not been of a good quality.

"The tank, now completed, receives its contents through the supply-pipe; the oil coming through, it may be, miles of piping, either direct from the wells, or from other similar tanks, or from barges laden with the oil in bulk. In this way, the oil-producing country is threaded with countless miles of piping, sometimes above ground, sometimes on or beneath its surface, and sometimes in the beds of rivers.

"Some tanks are on the tops, others on the sides or in the hearts of mountains, others at their base. Sometimes they are miles apart. Sometimes they cluster together in particular localities by the dozen. Frequently we find knots of tanks only from five to ten feet apart; hence all morally certain of destruction by the fire that seizes upon any one of them. On the other hand, where wiser foresight has prevailed—as on the Anchor Farm, 'Chestnut Hill,' opposite Parker's—it is made obligatory upon tank owners to build at least 200 feet apart. There are twelve tanks upon the summit of this hill. At 'Mount Nebo,' just south of Parker, there are ten tanks separated by distances varying from 100 to 150 feet; while at Montrose there are ten new tanks building on the river bank, separated from each other by only fifty to seventy-five feet."

With so satisfactory a description of the condition and surroundings of these tanks, we may now turn to the problem announced at the beginning, namely—why are they so liable to destruction from lightning; for statistics show that not less than 85 per cent. of all the losses suffered by the destruction of such tanks and their contents by fire, is attributable directly to this agent; and the relative liability of such tanks to destruction from this cause, as deduced from a comparison of the number of tanks existing and the number struck, with the number of buildings existing and the number struck in the same locality, and therefore exposed to the same dangers from meteorological causes, is immensely against the tanks.

The causes of this utterly disproportionate liability to destruction from the cause just specified, the writer is disposed to seek, first in certain defects in the mode of construction of the tanks, and second, in the inadequacy of the means that (in some cases) have been adopted to protect these structures from the lightning stroke. We say "in some cases," advisedly, for although there are, doubtless, isolated instances where an

effective and intelligent system of protection has been employed, in the majority of cases, we are credibly informed, not even an attempt at protection is made.

It would be very hazardous to affirm of any system of construction and rodding—no matter how perfect in theory—that it would perfectly protect such oil tanks from destruction by lightning, but there is no doubt whatever in the mind of the writer, that the liability to destruction from lightning and the percentage of accidents from this cause may be enormously reduced by the universal adoption of a few modifications of the existing general practice.

We will present certain suggestions upon this subject in our next. W.

ANNUAL REPORT OF THE HARTFORD STEAM-BOILER INSPECTION AND INSURANCE COMPANY, 1875.

COMPLETING THE FIRST DECADE.

II.

Boiler Explosions.—The record of explosions kept in this office since our last Annual Report shows 139, by which 191 persons were killed, and 267 wounded.

We have been able to investigate many of these cases, and from the experience of another year, find no reason to change our views relative to the cause of these accidents. Where opportunity for a full examination is given, the mystery is usually dissipated.

We are not surprised that many coroners' juries have rendered a verdict, "cause unknown," or "mysterious providence." There are few fields of investigation where cause and effect are apparently so remote from each other as this. For instance, one visits the scene of an explosion which has just occurred. He finds a building partly in ruins with brick, mortar, timber, machinery, and stock, raw, wrought and in process, mingled and mixed in a confused mass. Part of the exploded boiler is in the ruins, while other portions may be found three or four hundred feet distant; adjacent buildings are more or less injured, and terror and dismay are depicted on every countenance. What caused all this destruction? Was it carelessness, or neglect, or both?

The expert must go to work cautiously and carefully to unravel this "mystery," for to the casual observer it is a mystery.

Faulty construction often has much to do with these accidents, but careless management is probably a fruitful cause. A boiler is purchased for a particular pressure. The mill for which it furnishes power is small, and its capacity is abundant. But by and by an unusual demand springs up for these particular goods. New machinery is added and the boiler, which perhaps has been in use several years, is steamed up to an extraordinary pressure, to meet the requirements of the increased work being done. Now it will be plain to every reader that this is treading on dangerous ground. Yet it is what is done again and again, and not until actually forced to get a new and larger boiler will the manufacturer do it. I do not say this is true of all, but there are many such cases. If a boiler had exploded under such circumstance, it would have been no mystery to a person familiar with boilers and their weaknesses.

There is among some steam-users a great reluctance to keep boilers in good repair. If a leak is discovered which does not particularly interfere with the work in progress, it is neglected and allowed to go on increasing until perhaps a large area of plate is badly corroded. A crack is discovered by an inspector. He reports it to the owner of the boiler, and recommends that although it is not actually dangerous, he should have it repaired at once, to save future expense and trouble. At the next inspection he finds that nothing has been done, and that the crack has increased in length, and is rapidly approaching a dangerous point. It becomes necessary to say to the owner of the boiler, you must make the repairs required, or take the responsibility of running the boiler on your own shoulders. The chances are that such an owner will become violent, and declare inspection an unmitigated nuisance. In the majority of cases manufacturers are anxious to know the exact condition of their boilers, and will not run them a day

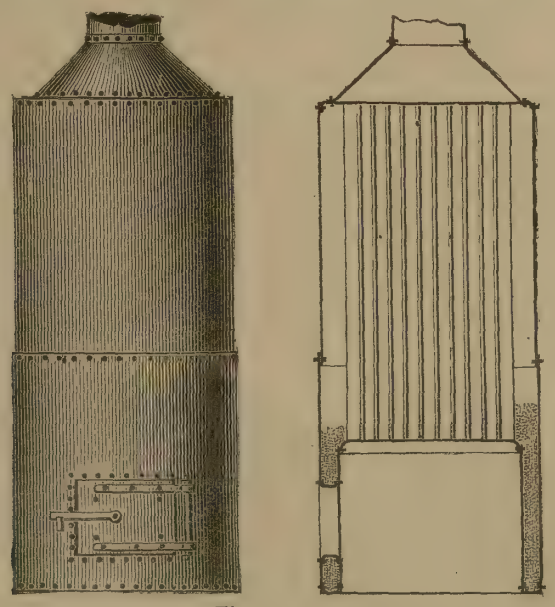


Fig. 10.

if thought to be in unsafe condition. Our whole experience goes to show that generally the steam user is in full sympathy with this Company in its efforts to prevent any carelessness in the use or management of boilers.

There are defects in boilers which can only be discovered by careful inspection. Hydraulic pressure cannot do it. Internal inspection reveals defects like the following: corrosion of plates; grooving along the edge of the inner lap of the sheet; crack or fracture running from rivet to rivet; accumulation of sediment or hard lime scale over the fire surfaces, causing the plates to be overheated and their strength greatly reduced; braces and stays, broken or corroded so badly as to have little strength left. Then there are the questions of feed, blowout, safety-valve capacity, steam-gauge, quality of feed water, etc., which have a direct and important bearing upon the safety and economy of boilers.

The question of construction is also an important one. A boiler may be constructed of good iron of proper thickness, the workmanship may be faultless, and every thing appear to be thoroughly and honestly done, and yet certain important and almost vital points have been overlooked. To illustrate. Our attention has been called frequently to upright boilers with no hand-holes and no means of removing the sediment which may have accumulated in the water legs, and upon the crown-sheet among the tubes. Fig. 10 will explain the condition of things.

It will be seen that there is no way of removing the accumulation of sediment which has deposited in this boiler. The furnace sheets are overheated and weakened, and they frequently give out, or the lower tube sheet, being greatly weakened, "comes down."

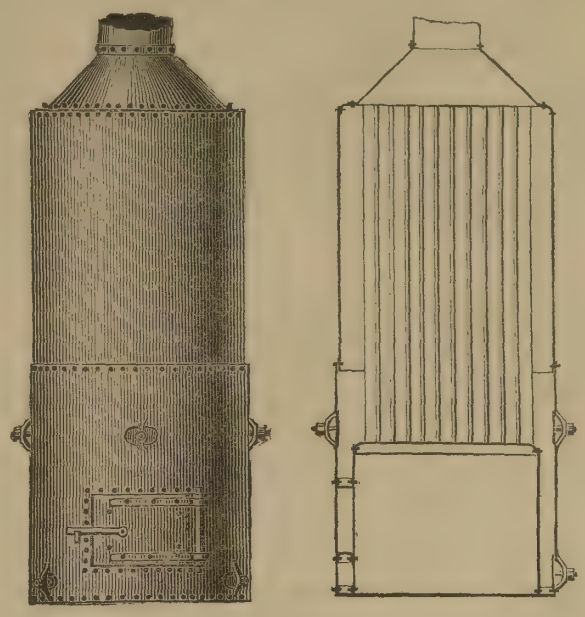
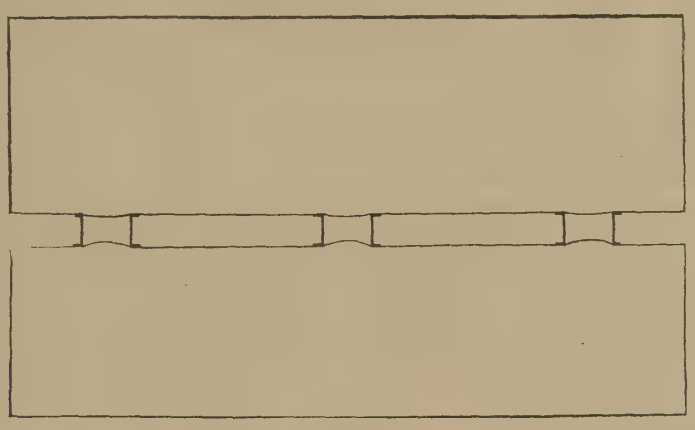


Fig. 11.



Fig, 12.

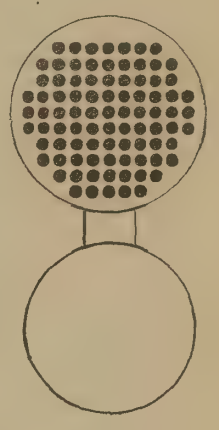


Fig. 13.

Every boiler of this construction should be provided with hand holes for both the water legs and crown sheet, as is represented in Fig. 11, which is the same size and construction of boiler.

It is quite common to meet with what are known as Union Boilers. They are constructed with one boiler above the other, the two being connected by two or three water pipes or legs, as represented in Fig. 12. End view of same, Fig. 13.

Another type is the *Trinity boiler*, which consists of one large boiler at the bottom and two smaller ones connected at the top, as in Fig. 14.

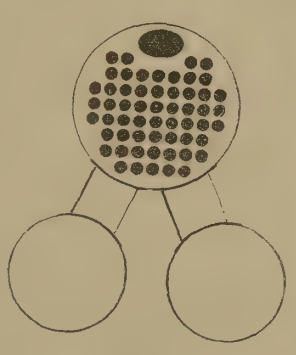


Fig. 14.

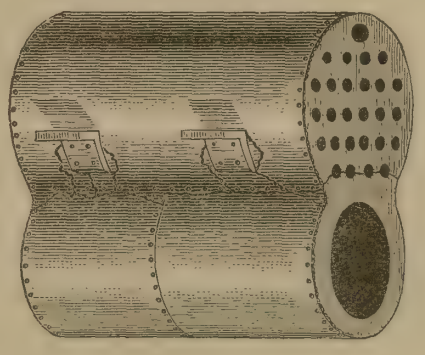


Fig. 15.

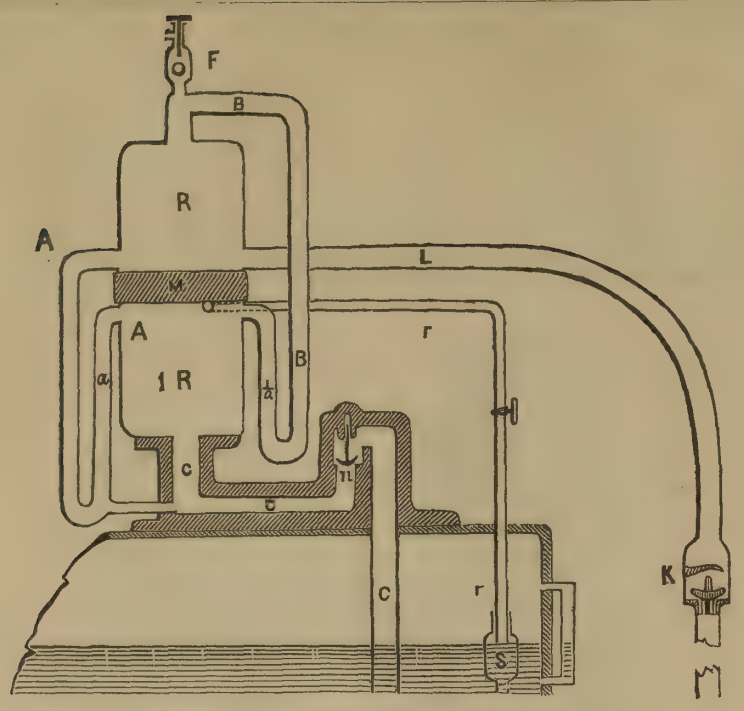
Fig. 16.

These two types are used considerably in different parts of the country, and work very well, with good water and good management.

Boilers are sometimes constructed on a plan entirely at variance with any rules hitherto made use of. An effort has been made to construct a boiler similar to the Union boiler, with a continuous connection or leg. This idea was doubtless brought out under the impression that it was a great improvement. But a moment's examination will show that it has very weak points. It is illustrated in the following:

A boiler of this description exploded in Ellsworth, Me., July 3, 1875. It was 6 feet long, 26 inches in diameter below, and 20 inches in diameter above. It had 26 tubes, each 3 inches in diameter. Shell and heads were made of iron $\frac{1}{4}$ inch thick. The boiler had four stays $\frac{1}{4}$ inch thick, $8\frac{1}{2}$ inches wide $\times 17\frac{1}{2}$ inches long. The boiler was running at 75 lbs. pressure when the explosion occurred. In Fig. 15 the lines of fracture will be easily seen. The form of staying is shown in perfect condition in Fig. 16.

(To be continued.)



JAGN'S SELF-ACTING BOILER FEEDER.

[RUSSIAN DEPARTMENT, MACHINERY HALL.]

The annexed cut gives a sectional view of a boiler-feeding device made by S. G. Cohnfeld, Zaukeroda, near Dresden, Saxony, and exhibited by the patentee, Mr Jagn, in the Russian section.

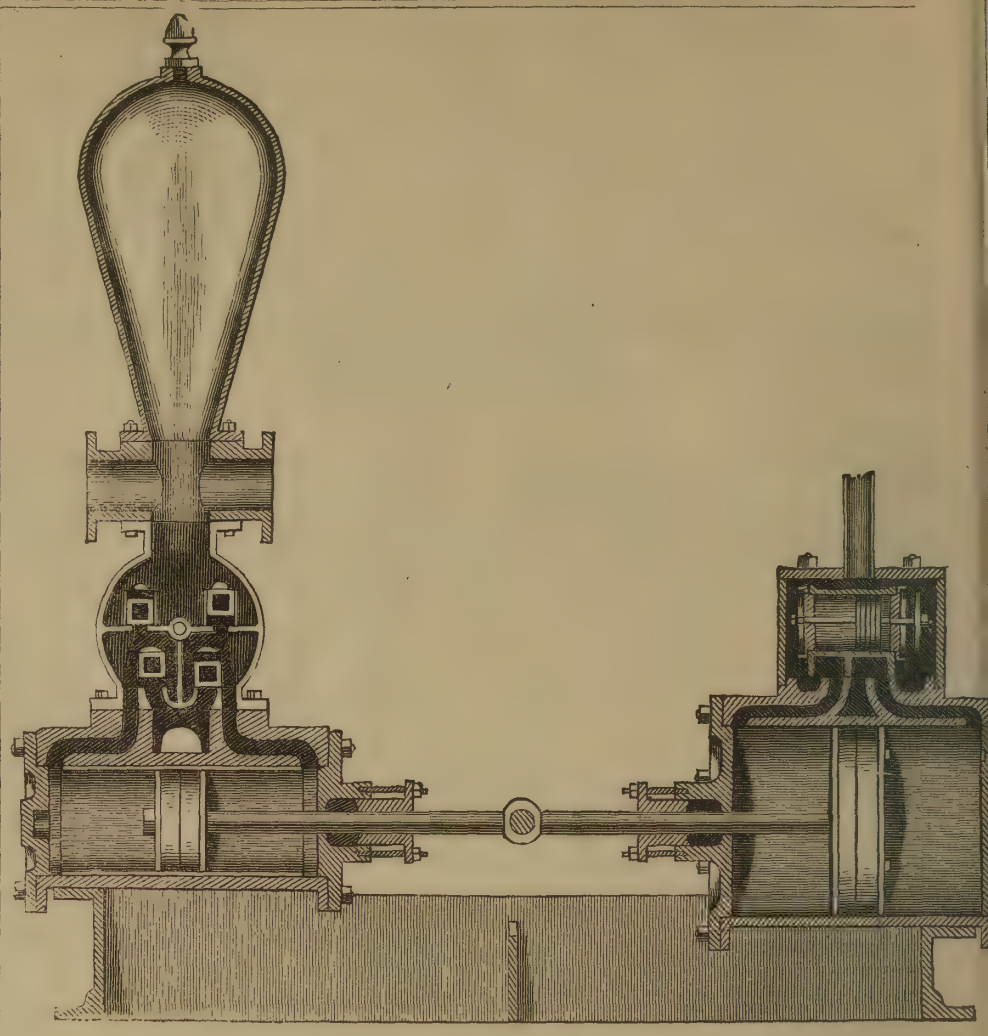
The advantages of maintaining a constant water-level in any boiler need here no special presentation; hence we give at once a description of the construction and operation of the apparatus.

Let it be supposed that it is attached to the boiler, as shown in the engraving, and is filled with water, and that the small pipe *r*, is still closed by water at S, which represents the ordinary water-level in the boiler. The valve *n*, closed by the pressure of steam in the boiler, while separating the feeder from the boiler, partially interrupts the communication between the two. The water-evaporating, its level sinks, and the steam will enter at S and pass through the pipe *r* into the chamber R 1; here, on coming into contact with the feed-water, which has a lower temperature, it will, though partly condensing, press upon it with the steam pressure as in the boiler. As soon as this equilibrium is established on both sides of the valve *n*, it will be opened by the weight of the water column in R 1, and the feed-water flow into the boiler through the pipe *c*. The level will rise and again close the orifice of the pipe *r* at S. A portion of the steam contained in R 1 will then pass through the pipe B into the upper chamber R, and its pressure upon the water will force the latter into the lower chamber R 1. A vacuum now being formed by condensation of the strain in the lower chamber at the moment when the water flows into it through the pipe *a*, and also by condensation of steam in the upper chamber; the external pressure of the atmosphere will force the water in the feed tank, through the suction valve K and the pipe L, into the upper chamber R and fill it. The two chambers are separated by a non-conducting substance M. As soon as the level of the water sinks in the boiler, the steam passes at S through the pipe *r*, into the chamber R 1, and the same process repeats itself. The condensation in the lower chamber 1 R takes place very quickly, and also the flow of water from K to R, so that the apparatus empties itself into the boiler from three to four times a minute. The feed-water may be sucked into the apparatus either from a tank at a lower level, as shown in the cut, or may flow into it from a tank at a higher level. The patentee claims that the feeder will draw cold water from a depth of 18 to 20 ft, or water at 122° Fahrenheit from a depth of 13 feet, and will also act with water of 167° Fahrenheit, supplied under pressure. F is a small valve for the escape of air. The end of the pipe *r*, is provided with a small regulating cup, the object of which is to counterbalance the oscillations of level in the boiler.

The action and construction of the apparatus are so simple that it should not get out of order, but in case of possible derangement, there is an alarm whistle to notify the fireman of low-water.

One of these devices is in operation, attached to the "Rogers & Black" boiler, in the Boiler House, No. 4. It maintains the water-level constant; and the fireman in charge speaks of it in very favorable terms.

TO INVENTORS.—We frequently write to inventors and manufacturers of new articles which appear to have decided merit, asking them to forward us the requisite data to enable us to present the matters properly before our readers. The data desired are, to quote from several of our communications, "duplicate circulars, concise detailed mechanical descriptions, sectional drawings, and good electrotypes." The amount of rubbish received from some sources, under the head of "descriptions," would astonish any one to whom we should show our correspondence. There are most frequently such pieces of valuable and characteristic information as that the device described is not only "constructed throughout in the most careful manner of the best imported materials only," but that it is the best, the cheapest, the most durable and efficient, and in fact, the *only reliable* and *satisfactory* affair of the kind which has been or can be produced. We are frequently favored with the remarkably interesting and valuable information (intended to be used as an *editorial*), that "we understand that orders are now coming in so rapidly as to tax to the utmost, even the unrivalled manufacturing resources of the proprietors;" or that "we learn incidentally that orders are coming in from all parts of this and other countries, and that several of the Centennial Commissioners have expressed themselves as delighted with the invention, and have ordered several for their Governments." It would require a very liberal stretch of the imagination to conjure a "mechanical description" out of such statements; but the lists of *prices* kindly sent us for publication are even less valuable as data towards writing intelligent descriptions for our readers. Our waste-basket is capacious and absorbing, and rids us of much rubbish of this character; but our time, patience, and postage account have heavy demands made them in consequence of such lack of comprehension or of good taste on the part of many of our correspondents. [EDS.]



HARDICK'S NIAGARA STEAM PUMP.

(HYDRAULIC ANNEX, MACHINERY HALL.)

Mr. Chas. B. Hardick, 23 Adams Street, Brooklyn, N. Y., exhibits the "Niagara" pump shown herewith.

The sectional view shows the arrangement of steam and water valves and other working parts; the scale being one inch to the foot. It will be seen that the general arrangement is of the simplest description. The main steam valve is a small cylinder having a piston on a rod and fitting closely inside of the steam chest. This piston is fixed immovably upon the rod, and the valve receives its momentum from the steam operating upon the piston, and forcing the valve outward from the centre alternately. This main steam valve has upon the under side a flat face or surface, in which are steam ports corresponding to ports in the face of steam cylinder, and thus it will be readily understood that it has its seat on the face of the steam cylinder, and rests thereon by its own gravity; the design being that by its motion it shall compensate for its own wear. In the side of this main valve is a small auxiliary or common slide valve, which also works upon the face of the steam cylinder, and at rest always has one port open. With either of its ports there is a communicating port in the face of the steam cylinder, which admits steam to the port of the main valve, by the alternate motion of which steam is admitted to the main piston in the steam cylinder; this small or secondary valve receives its motion from an inside lever fitted on the rock shaft and inside of the steam chest. There is an outside lever fitted on the rock shaft, attached to a connecting rod which fits upon a cross-head fastened on the piston rod. Thus, at every stroke of the main piston, this small slide valve must be reversed; hence steam is unfailingly supplied to the main valve, resulting in a positive motion of the pump whenever steam is applied, without regard to the position of the main piston. There should then be no centre or dead point for the pump to set upon—an object of vital importance in mining operations, or in other situations where a steam pump is liable to become submerged. The maker states that this pump has acquitted itself in this respect with entire satisfaction when covered with water to a depth of forty feet. The packing in the steam cylinder consists of a piston, follower, and three rings (one inside eccentric ring to expand the two outer rings.)

The water cylinder is lined with a composition bush to withstand the action of acids or liquor. This bush is of sufficient thickness to stand two or three borings when ths lapse of time renders this neceesary. The water cylinder packing is a piston, follower, and rings, ordinarily of composition metal, to adapt it for pumping hot or cold liquids; the water ports in the cylinder are directly in communication with suction ports in the valve chest, whereby great economy in duty is attained. The two discharge valves are seen immediately over the suction valves; the valve seats are of good composition metal, as also are, ordinarily, the valves. These valves are square in form, and have four faces, which may be used in succession, and are guided by partitions in the chest, and by bonnets at the end on the valve chest, and are accessible by the removal of one nut. The discharge piece has, like the suction in the cylinder, two openings, either or both of which may be used as required. The air chamber is also separate. It will here be noticed that while simplicity characterizes all the various parts, so that an expert is not required to take them apart or put together, yet there is eventual economy to the purchaser in case of accident or freezing—having only to replace the portion affected. The excellence of these pumps is well attested by general use.

BORINGS for a new subway under the Thames have been commenced at Woolwich, and the work is expected to be completed within six or nine months. The tunnel is intended to replace the steam ferry boat, which usually conveys some thousands of persons daily between North and South Woolwich. [*The Engineer*, xlii, 135.]

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The Dudgeon Rotary Engine.—The inventor of this engine is now in London, offering to put up his machine in competition with any other engine.

American Chilled Calender Rolls in England.—We note with pleasure that a prominent firm in Leith advertises chilled castings from America finished in Leith by the patented grinding machinery of J. Morton Poole & Co., of Wilmington.

The Atlantic and Pacific Canal.—The *Panama Star* states that it is currently reported and generally believed that Mr. Henry Meigs has concluded a contract with the Government of Nicaragua for the construction of the Interoceanic Canal across that country.

—An order has been received at Chatham from the Admiralty in which attention is called to several cases which have occurred of the priming of boilers in her Majesty's ships, caused or greatly augmented by the admission into the boilers of water containing solid matter and impurities of various kinds. The use of such water, especially with new boilers, is therefore to be avoided. The order also directs that the boilers of ships at the dockyard should never be filled from the basins, either fresh or salt water from the mains being used, or the boilers run up on the sideway, at the top of the flood tide. On all occasions reliance is placed on the discretion of the officers to prevent, as far as possible, the necessity for running water into the boilers from shallow depths, or from employing impure water of any kind. [*The Engineer*, xlii, 134.]

—Toronto Car Wheels are advertised in London.

The Progress of the Boring Machine in Cornish Tin Mines.—We hear from Camborne that the "Barrow Drill" made by Messrs. Hosking & Blackwell, of Barrow-in-Furness, at work in Dolcoath mine, has made very great progress throughout the past week. The first week of the first experimental month 3 ft. only of the end were driven, but in the first week of the next month 8 ft. of the end were cut through. Manual labor would average 1½ fathoms a month; in the first four weeks of its labour the machine accomplished 2 fathoms; now it is working at the rate of 5 fathoms 2 ft. a month. Now as to the cost: 1½ fathoms by men would be paid £37 10s. for. The two fathoms by the boring machine cost £100, but the 5 fathoms 2 ft. will only cost the same sum, as far as wages go, though the £100 will be added to under the item of materials. We understand that in order to work the machine three first-class men are employed at £8 per month, three second-class men at £4 10s., three others at £3; or £46 10s. for miner's wages. Compressed air costs £15 a month. Explosives, coals, candles, &c., are estimated at £1 a day; engineer, £5 a month; smith and boy, £7 ditto; engine man, £6; in all £103 10s. The end was set to the miners at £25 a fathom. The machine is to have the same amount, with 15 per cent. added if it accomplishes double the work manual labor would have done. Already, however, other mine managers see how boring machines may, probably, be worked more economically. Many mines can manage to work an air-compressing engine from existing boilers with only a small additional amount of fuel; or one compressor may work three boring machines. On the £46 paid to underground workmen a saving can be gradually effected of £10 a month. All expenses, indeed, except those for materials, may be reduced. Unless there is some change of ground at Dolcoath, or other causes which operate in favor of the boring machine, the inference we draw from what we hear is this—that the men get, with their brief experience, better able to work the machine, and consequently show a very much larger result; and that the adaptability and economy of the compressed-air-driven borers can be clearly seen. A little more time and practice will solve the question. [*Cornish Telegraph.*]

MINING, METALLURGY AND MINERALOGY.

American Steel at the Centennial.—It is a source of no little satisfaction to us to find the views we advanced regarding the increase in the use of American steel in this country, and the decrease in the use of English, so amply confirmed by the English journals and their trade reports. The British *Trade Journal*, speaking on this subject, says; "It is no longer possible to disguise the fact that English steel has had its best day in the American market. Everything points to that conclusion, and our consul, writing from San Francisco, says 'it is only a matter of time when the foreign manufactured article will cease to be imported. Large consumers of steel are using American in the manufacture of axes, chisels, scythes, and edge tools generally, and hammers and sledges.'" The opinion of the *Ironmonger* and the Sheffield *Independent* were quoted in our last issue, and this is not the whole story. We are exporting to England steel and its manufactures not spasmodically, but regularly. To be sure, the amount is not large, but the fact that it is done at all is significant. We well remember the first public announcement of Disston's consignment of saws to Sheffield, and the fun the English trade journals poked at us about it. Now they say: "In the saw trade the position of things is being reversed. Formerly we supplied America with saws; now, manufacturers there have not only secured almost complete monopoly of their own markets, but they are sending their goods here in large quantities. There are only about two Sheffield houses who are now sending saws to America; but several here are buying from them, as they can do so on more advantageous terms than they can produce the goods themselves."

And if they had added the saws are better, the arch would have been complete. If we are rightly informed, only American steel is used in manufacturing Disston's saws. We believe that the position that American steel holds to-day has been hastened by the very attacks made upon it, and more especially that of May, 1874, before the Committee of Ways and Means. This has aptly been termed the Waterloo of the importers. The testimony then adduced as to the quality of American steel from those who had given it careful and thorough trials, that its opponents were forced to try it, and the results we have already given. [*The Iron Age*, Sept. 7, 1876.]

New Minerals.—Prof. Sheperd has named and described the following new mineral species, viz:

Vanuxemite—occurs in small patches scattered through a fine ochrey aggregate, proceeding from the decomposition of several zinc ores. It is massive, dense, and with an even concoidial fracture. Color—white, dull. H.=2·5—3, G.=2·5. Emits a feeble clayey odor when breathed upon. It is a hydrated silicate of zinc and alumina. Found at Sterling Hill, N. J. Keatingite (*probably* a new species) closely resembles fowlerite in crystalline structure, but the angles of cleavage prisms are 64° and 116°. Does not lose lustre on weathering, H.=4·51—5, G.=3·33. It is a silicate of manganese, zinc and lime. Found in a mass of yellow garnet at Franklin, N. J.

Calcozincite — massive, fine, granular, interpenetrated with fibres of asbestos and sussexite. Color, light orange-red, streak of lemon yellow. H.=3·5, G.=3·95. Composition—zinc oxide 81 per cent., lime 7·56 per cent., carbonic acid 5·80 per cent. water 4·26.

Euchlorite—massive, in coarse elongated scales. Color, light olive green. H.=2·5—3, G.=2·71. It is a silicate of alumina and iron (magnesia) with water. Occurs at Chester, Massachusetts.

Pelhamite—forms irregular seams and masses sometimes a foot thick at the asbestos mine at Pelham, Mass. Closely resembles black serpentine. H.=5, G.=2·9—3·2. Composition similar to the above. [Abridged from *Am. Jour. Science and Arts*, III, xii, 231.]

CHEMISTRY, PHYSICS AND TECHNOLOGY.

The Durability of Impregnated Railway Sleepers.—At a recent meeting of German Railroad Directors, at Constance, the following statement was made by Herr Fünk, concerning the relative value of various processes of impregnating sleepers.

The observations upon which the accompanying statements are based, were made partly upon the Cologne & Minden, and partly upon the Hannoverian State Railroad.

Of pine sleepers (*Kieferschwellen*) impregnated with chloride of zinc, after 21 years of service, the proportion that had been renewed was 31 per cent.; of beech sleepers impregnated with creosote, after 22 years, 46 per cent. had been renewed; of oak sleepers, not impregnated, after 17 years, 49 per cent. had been renewed; of oak sleepers treated with chloride of zinc, at the expiration of 17 years, 20·7 per cent. had been renewed. In all of these cases, the conditions to which the wood had been exposed were very favorable—the roadbed being a very good one, and permitting of excellent drainage.

Test samples taken from sleepers that were allowed to remain at the expiration of the respective periods named, exhibited a perfectly sound cross-section.

The following statement contains the results of a similar set of observations made upon the Kaiser-Ferdinands-Nord R. R., viz:—

According to these observations, the proportion of renewals was, with oak sleepers (*not treated*) after 12 years of service, 74·48 per cent.; with oak sleepers, treated with chloride of zinc, after 7 years, 3·29 per cent; with oak sleepers, impregnated with creosote oil, after 6 years, 0·09 per cent; with pine sleepers, impregnated with chloride of zinc, after 7 years of service, 4·46 per cent,

The practice of the Kaiser-Ferdinands-Nord R. R., since the year 1870, has been to employ only oak for sleepers, which are impregnated either with chloride of zinc, or with creosote oil. [*Wochenschrift d. oesterr, Ingenieur-und Archit. Vereins*; No. 29, 228.]

Gold Incrustation on Bronze.—The gold incrustations of China and Japan may be imitated in Europe, says M. Christofle, with the battery. The drawing is laid in gouache (body color) on the article to be incrusted. The parts not covered with gouache are gone over with a varnish which is not attacked either by acids or alkalies. The object is placed, after connection with the positive pole of the battery, in a bath of very dilute muriatic acid. The lead salt of which the gouache is composed is dissolved, and the metal is attacked at the exposed points. If the hollow obtained is sufficient, the object, after careful washing, is placed in a weak, cold, gold bath, and subjected to the action of the galvanic current. The gold begins at once to be thrown down, fixing itself firmly in the hollows produced by the muriatic acid. When the latter are filled, the operation is interrupted, the varnish removed and the object polished. Silver incrustations on bronze can be produced in the same way. [*Iron*, viii, 266.]

Carbon di-Sulphide as an Antiseptic.—Herr P. Zöller publishes the statement that in an atmosphere containing a small quantity of the vapor of carbon di-sulphide, animal and vegetable matters are effectually preserved against decomposition or putrefaction.

The author affirms that a few drops of this substance is sufficient for the purpose, and since it volatilizes at ordinary temperature, the employment of heat is rendered unnecessary. In this manner, he adds, bread, vegetables, fruit of every kind (and fruit juices), and meat may be preserved for a considerable time in closed vessels. Upon opening the vessels, the unpleasant odor of the di-sulphide is very apparent, but upon airing the substances treated for a few minutes, it disappers entirely by volatilization.

In the case of meats, the flesh, after having been submitted to the above treatment for several weeks, is in no wise unpleasantly affected. [*Deutsche Industriel Zeitung*, Aug. 24th, 1876.]

MISCELLANEOUS.

A Marine Safe.—A proposed safe for vessels is a buoy with proper compartments for bullion, jewels, &c., and not liable to be sunk and lost for years, as has frequently been the case with ordinary bullion safes when the vessels carrying them have been lost. Patented by J. L. Goutey, New Orleans.

A Hose Attachment for Faucets might prove of value in extinguishing incipient fires caused by lamps, gas, matches, &c. Such an one is patented by D. G. Trembley, 103 South Fourth Street, Brooklyn.

British Reaping Machine Trials.—The Royal Agricultural Society's trials of reaping machines, interrupted by rain on Friday and Saturday, were concluded on Monday. The first prize (£15), second prize (£10), and the third prize (£5), for the best machines, with self-delivery in sheaf, were awarded to R. Hornsby and Sons, of Grantham, Lincolnshire. Two other machines of Messrs. Hornsby were highly commended, and one of the Johnston Harvester Company commended. For the best reaping machine, with self-delivery in swathe, the second prize (£10) was awarded to the Beverley Iron and Wagon Co., the first prize (20) being withheld, as the swathes were not so perfectly laid as they ought to be. For the best combined reaper and mower, without self-delivery, the first prize (£15), second prize (£10), and the third prize (£5), were awarded to machines of R. Hornsby and Sons, and another machine of the same firm was highly commended. For the best one-horse reaping machine, the first prize (£15) and the second prize (£10) were awarded to Messrs. Hornsby for self-raking machines, and the third prize (£5) to the same firm for a manual delivery machine. The manual-delivery reaper of William Mattison, of Leeming Bar, Bedale, Yorkshire, was highly commended. During four days' working, Messrs. Aveling and Porter's combination of a Crosskill reaping machine, with a traction engine, proved its ability to reap wheat and barley, both light and laid crops, on steep hills as well as on level land, and for this successful and valuable invention the judges recommended the council to award to Messrs. Aveling and Porter the society's special gold medal. [*Engineering*, xxii, 162.]

M. Leclanché has just constructed a new galvanic battery, which the *Annales Industrielles* thinks likely to render great service both in manufactures and in scientific research. The original oxide of manganese battery by the same inventor consists of a porous jar filled with pyrolusite, in which is contained the carbon forming the positive pole. This jar is immersed in a solution of sal-ammoniac in contact with zinc. M. Leclanché has, however, introduced several improvements into this battery. He has superseded the porous jar by conglomerating the oxide of manganese, mixed in nearly equal parts with carbon, but with the addition of a small quantity—5 per cent.—of resin for the purpose of giving consistency to the mass. These three substances, properly pulverized and intimately mixed, are conglomerated under a considerable pressure, and at a temperature of about 100 deg. Cent. (212 deg. Fah.) into a solid cylinder, which serves at the same time as a porous diaphragm and a positive electrode. But here a difficulty occurred. Under the influence of the current, an almost insoluble oxychlorate of zinc was formed, which was deposited in a crystalline form in the pores of the electrode, and considerably diminished its conductibility, so that the internal resistance of the battery increased very rapidly, occasioning considerable inconvenience, especially when used for telegraphic purposes. M. Leclanché has now got rid of the difficulty by inserting in the centre of the carbon and manganese electrode, while being moulded, a small cylinder of bisulphate of soda. This acid salt prevents the formation of the oxychlorate of zinc; and the battery preserves its regularity for more than a year without the necessity for renewing the water of the saline solution. It offers a much slighter resistance than other batteries, and gives out a considerable quantity of electricity. A single element of small size, presented by M. Du Moncel to the Académie, immediately caused a platinum wire connecting its two poles to become red hot. [*The Engineer*, xlii, 135.]

The Society of Engineers.—The third of the inter-sessional visits of the Society of Engineers for the present year was made yesterday, when the Members and Associates visited the Royal Victoria Victualling Yard at Deptford. There were present, among others, Mr. R. P. Spice, one of the vice-presidents; Mr. C. Barnard, Mr. Jabez Church, Mr. Copland, Mr. Schönheyder, Mr. Addenbrooke, and Mr. P. F. Nursey, secretary. In the absence of the superintendent, Mr. Grant, the visitors were received by his deputy, Mr. McKain, by whom, with the engineer to the yard, Mr. Storrar, they were courteously conducted over the establishment. They first visited the bakery, where they saw the flour and water mixed by machinery for the biscuits; the dough passed first under the action of grooved, and afterwards under that of plain rollers, driven by steam power, It was then passed on to cutting tables, where the biscuits were stamped from the sheet of dough and passed into the ovens. From the ovens they saw the biscuits conveyed to the drying floor above, which is heated by the waste heat from the open furnaces, and when they are subjected to a maximum temperature of 140° Fahrenheit for three days. After that they are removed to the stores and packed in bags for use in the navy, and in tin-lined boxes for export to distant naval stations. The productive power of the bakery is 44,000 lbs., or nearly 20 tons, per day in full work. From the bakery the visitors were conducted over the flour mills, when the successive operations of producing flour from the grain were witnessed and the engines inspected. From the flour-mill to the oat-mill was a short step, and there the visitors saw the oats shelled and ground into oatmeal. The chocolate, the mustard, and the pepper mills were then visited in succession, the chocolate mill not being at work, as chocolate is made in cold weather only. The stores for the naval stations were then visited, as also was the "colour" department, where a series of Thomas's sewing machines, driven by steam power, and attended by women, was producing every kind of flag. In this department was a testing machine for sail-cloth, which is tested both for weft and warp. The breaking strain for the weft of No. 1 canvas, cut into strips of an inch wide, is 480 lb. Samples tested before the visitors stood 550 lbs. before giving way. The test for the warp is 340 lb, and samples stood 385 lb. before breaking. The bunting for the flags is also tested, the test being 100 lb. on the 6 in. wide strip. Samples tried stood 120 lb. The sail making department was next inspected, where steam-driven sewing machines of large size were at work, tended by men. The visitors were next conducted over the cask-making machinery department, where they saw the staves of the barrels steamed, bent, joined, and put together, and the heads formed and fitted, the majority of the operations being satisfactorily performed by Greenwood and Batley's machinery. The cooperage, where hand-made casks are still produced, was next visited, and then the general stores, which are of very great extent. The visitors were finally conducted over the rum stores. There the rum is received from the West Indies forty per cent. above proof, and is reduced by the addition of water to four per cent. under proof, and is vatted. There are over thirty vats of varying capacities, the largest being capable of holding 32,817 gallons of rum. The various processes were inspected with much interest, and the courtesy and attention of the officials throughout was most marked. The machinery, with the exception of the chocolate mills, is not of the most modern type, but is doing its work well, and is throughout the yard well kept. After a pleasant and instructive visit, some of the members and their friends dined together at the City Terminus Hotel. [*The Engineer*, xlii, 134.]

The Opening-up of Africa.—It is within the bounds of easy probability that before the lapse of many years the followers of the ubiquitous Cook will astonish the natives of the *Terra Incognita* which has so long been a blank on the maps of Central Africa. The grand tour in the days of our grandfathers ended at Rome or Madrid; now the familiar Tweed jacket is not unknown at the North Cape, in the Arabian Desert, and the northern skirts of Sahara. The conquests of the Khedive, and the missionary settlements on the lake sources of the Nile must, before long, introduce British holiday-makers to regions which have remained mysterious and unknown to the European nations from the dawn of history; and westward, the fine country fertilized by the head-waters of the Congo, rich in mineral as well as vegetable productions, may soon be as familiar to us as the Highlands of Scotland were when their kilted inhabitants followed the two Pretenders in their attempts to recover their hereditary crown. While Gordon Pasha is extending the conquests of his predecessors along the course of the Father of Waters, Mr. Donald Mackenzie, whose ancestor, mayhap, fought for the Old or the Young Chevalier, is engaged, so far successfully, in pioneeering the march of civilization to Timbuctoo. The latest accounts represent him as having discovered the mouth of the ancient inland sea, the bed of which now exists as a depression on the southern margin of the Great Desert. The conditions of his scheme appear to be, so far as the exploration has gone, unexpectedly favorable. The depression, at its commencement, is about 330 feet below the mean sea level, and the bar excluding the waters of the Atlantic only about a mile-and-a-half in length by about 300 yards wide, so that the engineering difficulties that exist in the way of making dry land again sea, and exchanging steam communication for the ship of the desert, will be easily surmounted. [*Iron*, viii, 259.]

—In a pamphlet recently issued by the Russian Government, detailed statistics are given with reference to the damage done by wolves throughout that empire. There are said to be not less than 170,000 of these animals, which, during last year were the cause of death to not less than 200 people; whilst the destruction of cattle and poultry by them is enormous, almost as much as by the cattle-plague. [*Nature*, xiv, 381.]

CENTENNIAL NOTES.

"L'AMERICAINE" SHEEPSHEARS.

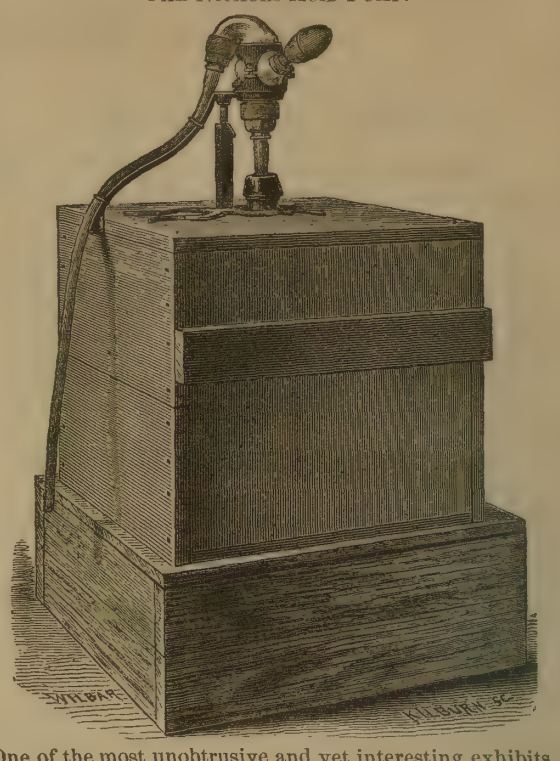
The annexed cut, although small, illustrates an excellent device exhibited by M. V. Pérard, of No. 29, Rue de Rivoli, Paris. It is composed of seven parallel steel blades, projecting from a plate of the same metal; a reciprocating knife or blade passes accross these blades and produces the cut; a jointed handle, with a proper spring, gives the necessary motion, a single hand being sufficient. The cut thus resembles that of a field mower. To operate it, the teeth or blades are thrust into the fleece, lightly touching the skin, and the cut is then made over the surface of all the blades. After shearing two or three sheep, it may happen that the edge of the traversing knife or blade may be slightly turned; to restore it to sharpness, it suffices to pass it lightly over a flat whet-stone, while holding the two branches closed. As to the smaller blades, the large knife should keep them sharp; however, after a certain amount of use it becomes necessary to put them in better condition. To effect this they should be passed over the surface of a stone, without removing them. The advantage claimed for the device, and, we believe, with justice, are rapidity of execution, economy in the wool, and the imposibility of wounding the animal. The new shears gives an equal cut without haggling the wool. The invention has received gold and other medals from several of the French societies.

Spain has a spocial building containing models of the accoutrements of war used in that country: canons, small arms, ambulances, pack mules, fortifications, &c.

In the Woman's pavilion hangs a whistle made from the tail of a pig, while an accompanying card contains the following couplet:

"There 's a proverb as old as Scotland's famed thistle,
That out of a pig's tail you can't make a whistle.
We believe we have done this wonderful thing,
And all who may wish to, may make this tail ring."

THE NICHOLS ACID PUMP.



One of the most unobtrusive and yet interesting exhibits, is that made in the Pump Annex, by Messrs. Nichols, Harris & Walker, of New London, Conn.; and consisting of a very ingenious, simple and effective apparatus for drawing off delicate or corrosive liquids, and for emptying carboys.

All know the difficulty of filling vessels from a carboy by tipping up the latter. The process is awkward and fatiguing, and the result very uncertain and unsatisfactory. Should the carboy contain any corrosive or fuming liquid, the operation is attended with discomfort and danger. One mode of ensuring the certainty of filling from a carboy, was to close its mouth, except to two tubes, and by forcing air in one with the breath, to drive the liquid out with the other. That this is highly unsatisfactory is confirmed by the record, which lies before us, of a suit in which the plaintiff, whose business it was thus to force vitriol from a jar, brings suit against his employer for injuries received by the absorption of the vitriol into his system—and gained the case.

There are two varieties of siphon pumps or acid dispensers, in one of which an air force pump replaces the lungs of the operator, and the other, suction is produced by an exhaust pump. The device here illustrated, and which from its wonderful convenience and merit we accord so much of our space, consists of a glass acid-pump, which is also converted into a siphon by the application of an extension tube to the nozzle. A large india-rubber air-bulb produces the vacuum and expulsion, but does not receive any of the liquid. The valves are glass poppets, riveted, while hot, into their seats. The joints in the pump, and of which there are several, are of accurately ground glass. The nozzle is also so jointed as to be properly flexible.

The apparatus may be used as a continuous siphon to empty a carboy or barrel, or as a measuring device; drawing small quantities with quite controllable ease. It is glass in all parts that come in contact with the liquid that it transfers, and hence will handle without injury any liquid except fluoric acid; if we may except an occasional renewal of a rubber packing ring in the case of nitro-muriatic acid. There is one variety with leaden pipes for heavier and rougher work, where lead is not corrosible. There is a very neat adjusting apparatus for the suction pipe, adapting it to any depth of vessel; and a convenient adjustable rest for the discharge-pipe.

The whole affair is under the most perfect control, and altogether deserves not only the prominence which we here give it, but the practical appreciation of all who have to handle delicate, corrosive, or fuming liquids. G

The Rubber Step Manufacturing Company, 43 Haverhill street, Boston, Mass., in the Annex to the Main Building, makes a display of its rubber steps for carriages and cars. The carriage steps embrace three patterns and three sizes. Long pads are used for cars, which are secured to the wooden steps, and in the center of the pad are the raised letters: Pennsylvania, Central Pacific, and Baltimore and Ohio. The carriage steps are made with the rubber moulded directly to the step pad, which is of malleable iron, and has a series of holes countersunk about its sides or edges, and in the vulcanizing process the rubber is forced through these holes in the plate and united with the rubber around the sides, thus locking the rubber covering effectually to the iron, and forming the step pad. For the convenience of manufacturers, each pad is furnished fitted to a short shank piece or stub, and is made detachable from the same, so that the rubber will not be injured during the process of welding.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, SEPTEMBER 23, 1876. NO 12.

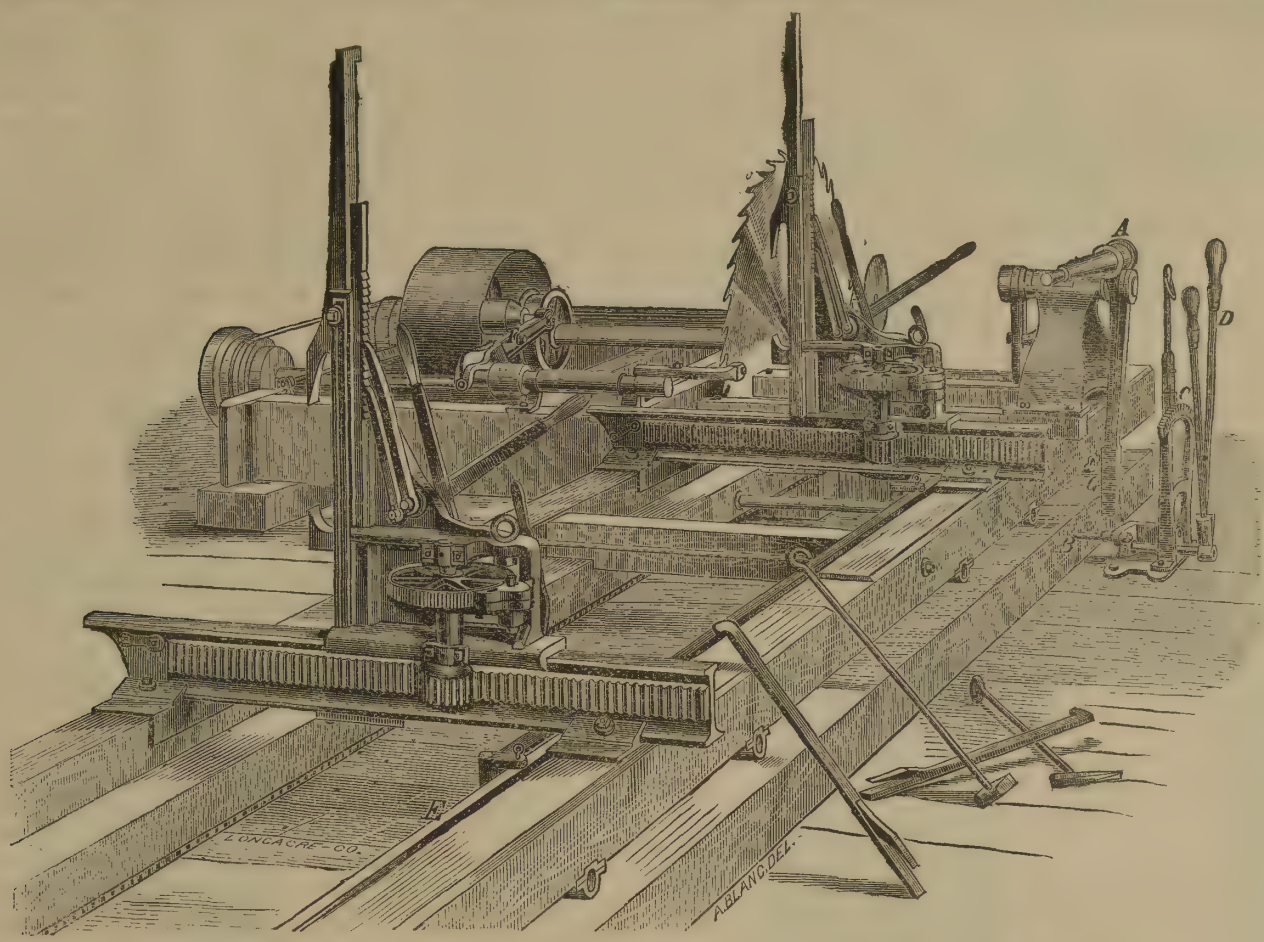


Fig. 1.

THE GRIDLEY AUTOMATIC SAW MILL.

East of the Glass Works, on the Centennial Grounds, is situated a saw-mill building erected by Messrs. E. W. Ross & Co., Fulton, N. Y., for the purpose of demonstrating practically the superior advantages of the Gridley automatic saw-mill, illustrated in the accompanying cuts. This mill has so many points of peculiar merit in its construction and operation, as to warrant us in devoting special attention thereto.

The carriage is a firmly built wooden frame, with the usual rack; but the head-block, feed-works, and set-works, are different from any other known to the writer, and possess points of peculiar novelty and value.

The knees of the head-blocks rest on heavy girder beams, wrought iron being chosen to obviate breakage by turning down heavy logs in frosty weather. The knees are 2 feet 4 inches high. The head-blocks are connected by a heavy square iron bar, (E, Fig. 1), and attached to the "self-setter" (A) to be hereinafter described. The dogs are located in a slot in the upright part of the head-block knees, and are forced easily and rapidly into logs, catching them and holding them tightly against the head-blocks. There should be no chance of their springing out and making irregular lumber, or allowing the log to fall against the saw and ruin it. A set-screw is used in frosty weather to hold the top dog with absolute certainty. Fig. 2 shows the head-blocks. It will be seen that the cant is taken up and held out firmly, permitting of through and through sawing.

These dogs permit of hanging up crooked logs and sawing completely up, without the slow and annoying process of turning down and changing ends. The immense saving of time by this one feature alone is worthy of particular notice. There is a "last-board dog" permitting of sawing clearly up to seven-eighths of an inch.

The lever of the feed-works (D) is near the setting indicator. C, coned pulleys, belted from the saw-arbor, drive the rack and carriage forward by a friction feed thrown in by a forward motion of the lever (D). A backward motion of the lever (D) throws in the "gig-back" belt, by means of the rack lever (F), carrying a tightener pulley on a stud in a slot on the end, and reverses the motion of the carriage. The carriage has its axles set slightly out of square, so that in gigging back it carries the log away from the saw a fourth of an inch, preventing friction and heating of the saw, and scratching of the lumber. This feature, combined with the stiffness of the track and carriage, enables very thin sawing to be effected, Mr. Gridley having sawed a $\frac{1}{18}$ inch veneer of hemlock in the writer's presence. The coned pulleys admit of a feed varying from $\frac{1}{8}$ inch to $2\frac{1}{2}$ inches. By a gentle motion of the feed lever the friction may be instantly decreased, so as to give slower feed when the cut is hard or heavy—this being effected without the sawyer leaving his position.

The set-works are peculiarly ingenious and effective. The wrought iron girders on which the head-blocks rest and travel, have racks on their sides, gearing with vertical pinions on the head-blocks; these again being actuated by pawls and ratchets, so as

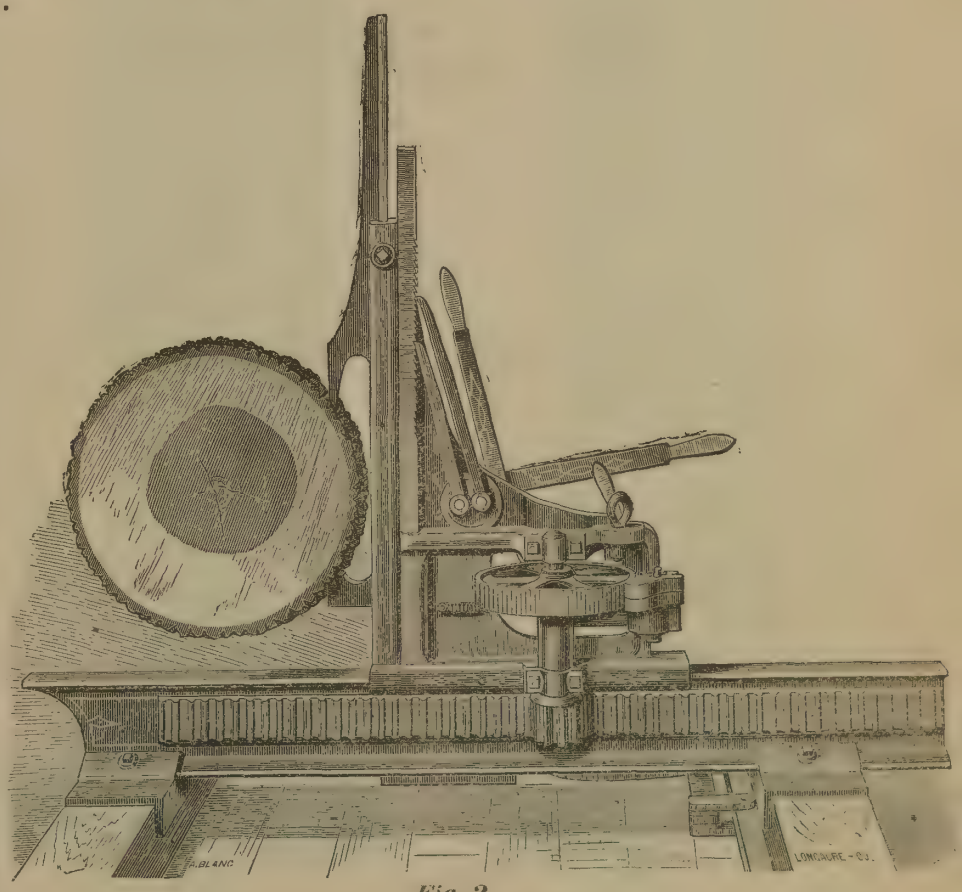


Fig. 2.

to set the head-blocks forward. By disengagement of a simple lever, either of the head-blocks may be set independently of the other, or both may be actuated by the set-works lever (C).

This arrangement is of itself ingenious, giving the sawyer full control of the feed at both ends of the cant, without leaving his position. But the most important feature of the set-works is their automaticity. The arm (G) extending down from the point (A), slides over the stud (B), by which the lever (C) can be raised or lowered, thereby sawing thicker or thinner, as desired. The setting lever (C) and the feed and gig-back lever (D), are within a few inches of each other; and after the log is dogged the

sawyer can saw a log through and through to the last cut, without leaving his position, or stopping any portion of the machine. The setting may be graduated from $\frac{1}{16}$ inch to $2\frac{1}{2}$ inches, as indicated by the notches on the quadrant of the stop-lever (C).

The saw mandrel is made of steel and held by a heavy iron frame, which is adjustable by a set-screw, permitting the saw to be kept in line without trouble. The bearings are heavy; the boxes self-oiling.

The solidity of this machine, and its accuracy and wide range of work, are noteworthy; but the automatic setting device should prove such a saving of time and labor as to entitle the mill to special commendation.

The engine driving the Gridley mill is of the vertical type, built by B. W. Payne & Sons, Corning, N. Y. It has a cylinder 10×10 inches, and is rated at 25 H.P. It is supplied by a boiler of 35 H.P. G.

[Since writing this notice, an attachment has been added to the carriage, by which the head-blocks (which formerly had to be run back by hand after the last board was cut) are now run back instantly, by pressing on a foot stop which throws in suitable bevel-gearing and brings the head blocks back rapidly and surely. The whole apparatus seemed, even before this attachment, to be as nearly automatic as possible; with this new and time-saving improvement, the only labor required of the sawyer is to dog the log. This attachment is intended to be applied to the larger mills, but is affixed to the small mill exhibited, in order to show its peculiar labor saving and economical features.]

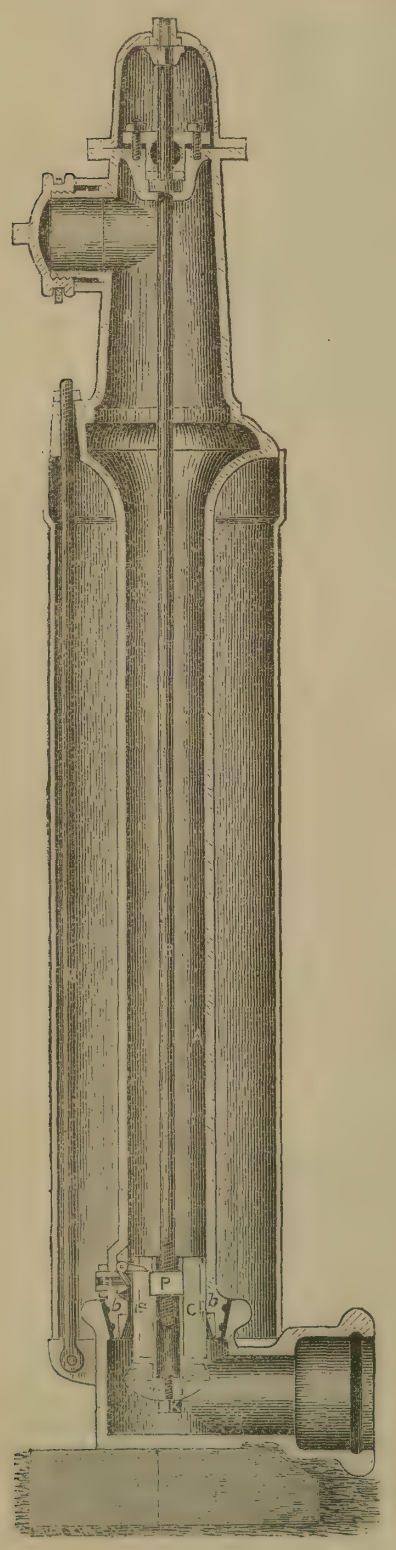


Fig. 1.

Fig. 2.

FLOWER'S FIRE HYDRANTS.

(MACHINERY HALL, CENTENNIAL EXHIBITION.)

The accompanying cuts represent the hydrants made by J. Flower & Bros., Detroit, Michigan.

There is an "auxiliary valve," to shut off the water from the mains whilst the hydrant is being removed for repairs, etc. This is operated by the main valve with the pressure of water, and requires no extra rods or screws to operate it.

Referring to Fig. 2, *e e* is the auxiliary valve, which is attached to the main valve by means of a hook formed on the bottom thereof. B is the base, or valve chamber of the hydrant, which is constructed of the form shown, with the intention of allowing a full and unobstructed discharge of the water when the valve C and *e* are open.

A noticeable feature in these hydrants is the formation of the joint on the standard. A cone, *b*, is cast on the bottom to a taper corresponding to the neck on the valve chamber; the standard is then placed in a cast iron mould (bored true), the same in all particulars as the "neck," and soft metal, as at *c c*, is poured around it, which makes a smooth elastic face to form the joint. All the hydrants are interchangeable at this joint. No digging or breaking of the surface is required to replace them.

To remove one of the duplex valve hydrants, the nuts on the top of the "holding down" rods M,M, are taken off, and the standard, A, lifted sufficient to turn the column, A, around until a stop on the valve chamber prevents it from turning further. This brings the hook on the bottom of the main valve, C, in position to unhook from the auxiliary valve *e*, when it can be lifted out.

The auxiliary valve, *e*, works or slides on guides F F.

To enable the nozzle for "hose connections" to face in any direction, irrespective of the lay of the "branch pipe" from main, the "holding down" rods are attached to a loose collar, N, around the neck of the valve chamber. This arrangement is not shown on Fig. 1, which was designed since the cut was made.

INDUSTRIAL APPLICATIONS OF ASBESTOS.

(Exhibit of the *Asbestos Patent Fibre Co., limited*, Machinery Hall, D. 69.)

So much has of late been written in the technical journals concerning the peculiar properties of asbestos and the numerous products that have of late been manufactured therefrom, that it will be unnecessary, in calling attention to the peculiar features of the above exhibit, to rehearse the general description of the properties of the mineral, and the historical points of interest in connection with its application to useful purposes in the arts, which will be familiar to the intelligent reader.

The exhibit of the company above named appears not to have attracted the attention it deserves on the part of those who take an interest in the progress of the useful arts, since it presents certain exceptionally valuable features, which give greater promise of the future extension of the employment of asbestos than any other.

As may be inferred from the name of the company, it is engaged in the production from the crude asbestos of a fibre which can be applied to the most varied uses. Upon the methods employed in the production of this fibre, upon the fibre itself, and upon the products manufactured therefrom, the company has proprietary rights.

By the process employed by Mr. Rosenthal, the superintendent of the company, the crude mineral, after being roughly disintegrated by mechanical means, is subjected to a chemical treatment, which effectually removes all the earthy, ferruginous and other impurities that it may possess. The product resulting from this treatment is a soft silky fibre—resembling in appearance the purest and most lustrous amianthus—and possessing in the most advantageous form all the properties that make asbestos valuable in the arts. The processes heretofore employed, owing to the brittleness of the crude mineral, and the difficulty of properly disintegrating and purifying it, have been very unsatisfactory.

The completeness of the Rosenthal process of treating the mineral, will be best appreciated by a personal inspection of the "utilized fibre," as the inventor somewhat inappropriately terms his product. The visitor who inspects the exhibit of the company will see there displayed masses of what appears to be the most beautiful amianthus, the fibres white as snow, and in length from a few inches to a foot and a half or more; possessing great flexibility and permitting of ready separation by the fingers. One of the chief elements of value in the process of this company resides in the fact that the removal of the mineral impurities associated with the crude mineral gives to the pure asbestos fibre that is produced, a much superior toughness and elasticity, thus materially enhancing its adaptitude for the numerous practical uses to which it is applied. From this so-called "utilized fibre," a number of manufactured products is made. From the interesting variety of articles displayed by the company, we select a few of the more prominent for notice.

The "asbestos fibre board" affords perhaps the best illustration of the utility of this interesting substance. It is designed by the manufacturers chiefly as a non-conducting covering to prevent loss of heat, by radiation and condensation, upon marine, stationary and locomotive boilers, steam pipes, etc. It has been extensively introduced for this purpose, for which, without doubt, it is admirably adapted. Its advantages and the mode of applying it, are, as we learn from the circular of the company, as follows:

"As it contains nothing but pure asbestos fibre, light and flexible, and not like the heavy cements, clays, and other non-fibrous compounds, it cannot be disturbed by concussion, and will not crack, char, or crumble. The board is manufactured in sheets of all thicknesses, 30 by 44 inches, and the process of applying it is very simple, no matter how irregular the object to be covered may be. Bands of asbestos board, $1\frac{1}{2}$ inches wide by $\frac{1}{2}$ inch thick and 15 inches apart, are fastened around the object to be covered, and upon these, slabs or boards, $\frac{1}{4}$ inch thick, are tacked, leaving an air space between the object covered and covering. When this is in place another layer of $\frac{1}{4}$ inch board is put on, so that all the joints of the first layer are covered, the whole making a neat, light, and perfect non-conductor."

The asbestos fibre steam joints manufactured by the company are also worthy of notice. They are made of any size and thickness, cut ready for use upon manholes, hand-holes, pipes, stills, retorts, blast-furnaces, etc. They are affirmed to possess qualities for this purpose superior to anything that has heretofore been introduced, and are claimed to be quite indestructible by either fire or water. The advantages claimed for this article are set forth in the following extract from the pamphlet of the company, viz:—

"It cannot be destroyed, as the same jacket can be used repeatedly if necessary to break joints, since its elasticity always remains the same, and it makes a tight joint when nothing else will. It is but half the weight of rubber, and costs much less per pound

—the price being two to one in favor of asbestos. * * * * * It has greater expansibility and contractibility, and adjusts itself to any rough joint."

The asbestos fibre packing made and exhibited by the "Asbestos Patent Fibre Co.," is claimed to have numerous points of superiority over similar articles with which the mechanical public is familiar.

"It differs," according to the circular of the company, "materially from anything offered for such purposes, and a rehearsal of its advantages will suffice to explain its superiority over the so-called asbestos packing heretofore manufactured, and for the following reasons, viz :—

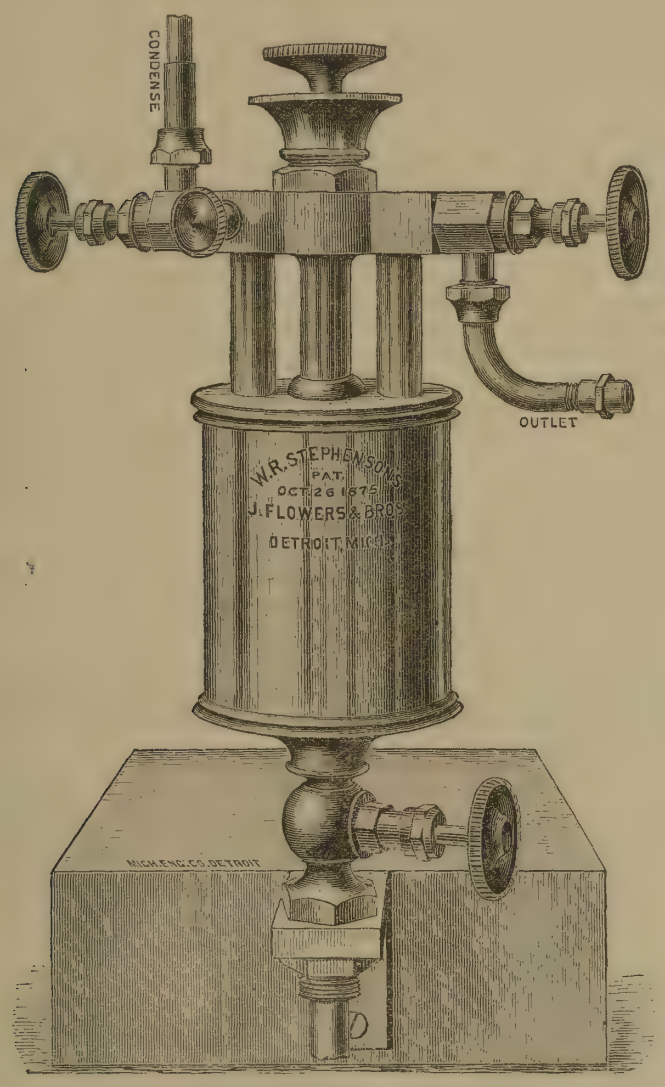
"1. It is manufactured from pure asbestos patent fibre board, in compact form, and will not fuzz or disintegrate, but will remain intact, no matter to what extent of wear exposed until removed from the stuffing box.

"2. As the fibre is thoroughly purified and free from grit or mineral matter, there is no fear of injury to the rod, which has been the objection to the numerous articles heretofore offered as asbestos packing.

"3. The packing is so interbraided with the asbestos strips, that its advantages to withstand any wear and tear are obvious.

The packing is manufactured of all sizes used, from $\frac{1}{8}$ of an inch to three inches in diameter, square, round and in convenient coils."

The foregoing description comprises the most prominent of the articles manufactured by the company, though by no means all; and there is no doubt but that the method of manipulating the mineral and the chemical treatment which is employed, embody decided and material improvements, which cannot fail to have an influence in extending the usefulness of asbestos in the industrial arts. W.



THE CENTENNIAL OIL CUP.

(MADE BY JAMES FLOWER & BROS., DETROIT, MICH.)

This oil cup operates by the displacement of the lubricant by condensed steam. The pipe attachment shown at the left is connected with any steam pipe; and the amount of water passing down the short glass tube shown to the left of the three connected with the cup, represents the amount of lubricant that is passing to the engine or machine through the outlet pipe. The adjustment may be made to any required degree of fineness.

This cup is to be secured by a bracket to any convenient part of the engine frame or wall of the engine room, etc., as the distance of its situation from the engine will not make any difference to the working of the cup; but in cold situations, it should be so placed that the oil or lubricant will not freeze; and as some oils have a tendency to thicken or gum when passing slowly through a pipe, some medium distance should be chosen, so that the feed pipe need not be *too* long.

THE LOWE WATER GAS WORKS at Manayunk, which have been erected to take the place of the local coal gas works, have been in continuous operation, with very satisfactory results, since the 4th of August last, supplying from 125,000 to 130,000 cubic feet of 20-candle gas daily. A detailed report upon these works will shortly appear in our pages.

CENTENNIAL EXHIBIT OF BALDWIN LOCOMOTIVE WORKS.

VI.

REMARKS.

The following tables give particulars of the performance of passenger locomotives of this class ("American" pattern, Pennsylvania Railroad's Class C, described in our last issue), in working the passenger traffic of the Pennsylvania Railroad.

Statement showing Rate of Speed, Number of Stops Made, Kind of Cars, and Average Weight of Five of the Express Trains on Pennsylvania Railroad Division.

SCHEDULE.	BETWEEN	Distance.	Rate of Speed per hour.	Number of Stops.	Kind of Cars in Train							Average Weight of Train in Net Tons, exclusive of Engine.	
					Passenger.	Pullman.	Combined.	Baggage.	Express.	Mail.	Postal. Postal Tender.	Empty.	Max. Loaded.
Day Express.	Pittsburgh & Altoona.	117	32 6-10	none	1	2	1					101	112
" "	Altoona & Harrisburg.	132	37 7-10	1	1	2	1					101	112
" "	Harrisburg & Philada.	105	34 1-10	none	1	2	1					101	112
Limited Mail.	Philada & Harrisburg.	105	33 2-10	1	1	2	1				1 1	140	171
" "	Harrisburg & Altoona.	132	37 7-10	none	1	2	1				1 1	140	171
" "	Altoona & Pittsburgh.	117	33 4-10	"	1	2	1				1 1	140	171
Fast line East.	Pittsburgh & Altoona.	117	31 3-10	"	2	4		1			1 1	205	253
" "	Altoona & Harrisburg	132	35 3-10	"	2	5		2	1		1 1	264	336
" "	Harrisburg & Philada.	105	29 3-10	"	2	5		2	1		1 1	264	336
Pacific Express West.	Philada. & Harrisburg.	105	25 2-10	2	2	4		1	5			241	319
" " "	Harrisburg & Altoona.	132	28 3-10	11	3	4		1	4			246	318
" " "	Altoona & Pittsburgh.	117	25 2-10	14	3	3		1	4			218	288
Cincinnati Express West.	Philada. & Harrisburg.	105	29 3-10	1	2	5		1	1	1		224	276
" " "	Harrisburg & Altoona.	132	34 5-10	none	2	5		1	1	1		224	276
" " "	Altoona & Pittsburgh.	117	31 9-10	"	2	5		1	1	1		224	276

Statement showing Run of Engines, Character of and Maximum Grades, Average Train Hauled, and Pounds of Coal consumed per Engine Mile by Class C Engines on Pennsylvania Railroad Division.

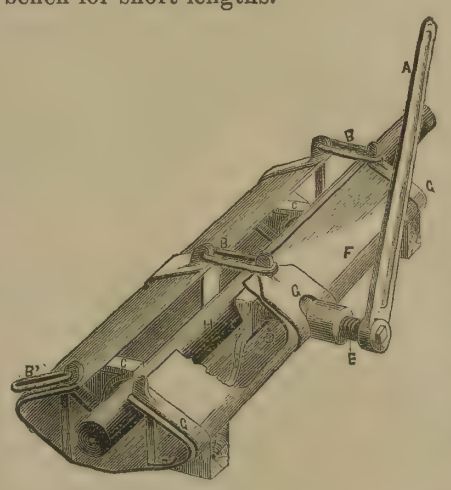
RUN OF ENGINES.	BETWEEN	Character of Grades.	Maximum Grade.		Average Train.	Pounds of Coal per Engine Mile.	
			East	West		Average	Minimum.
Day Express & Limited Mail.	Philada. & Harrisburg.	Undulating.	40	49	5.0	34 0	30.0
Cin. Express and Fast Line.	" "	"	40	49	8.0	40.0	35.0
Atlantic Express & Fast Line.	" "	"	40	49	9 5	36 0	28 0
Day and Cin Express.	Harrisburg & Altoona.	Ascending West		21	7 0	37 0	33.0
Fast Line, East and West.	" "	" "		21	8 5	35.0	31.0
Cin. Express and Fast Line.	Altoona & Pittsburgh.	Undulating.	52	95	7 5	46.0	41.0
Day Express & Limited Mail	" "	"	52	95	5.0	42 0	37.5

On the 95 ft. grade between Altoona and Pittsburgh the C locomotives always have one helper, and sometimes two, on the above trains. On the 52 ft. grade coming East, fast Express Trains have one helper if seven or more cars. Atlantic Express makes schedule time (25 miles per hour) with eight cars.

SCOFIELD'S STRAIGHTENER OR BENDER,

FOR SHAFTING, AXLES, TUBES, RAILS, &c.

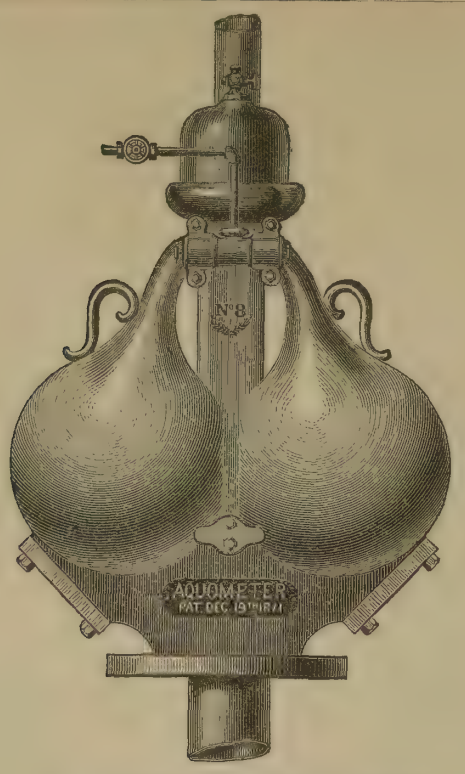
"There has been a want of some device by which the straightening of shafting could be done quickly and accurately without removing the work from the centres. The 'Scofield Shaft Straightener' meets this want; the apparatus is light and can be easily handled, yet it is of sufficient strength for the purpose required. It can be placed upon the shears of the lathe, and moved along the entire length of the work. It is especially adapted to removing short bends which frequently occur in long lengths of shafting. The lightness of the straightener adapts it eminently for line and counter-shafting, without necessitating the time and trouble of removing hangers and detaching couplings, as it can easily be applied to the shaft while in position. It can also be used on the bench for short lengths.

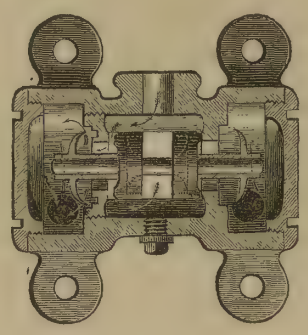


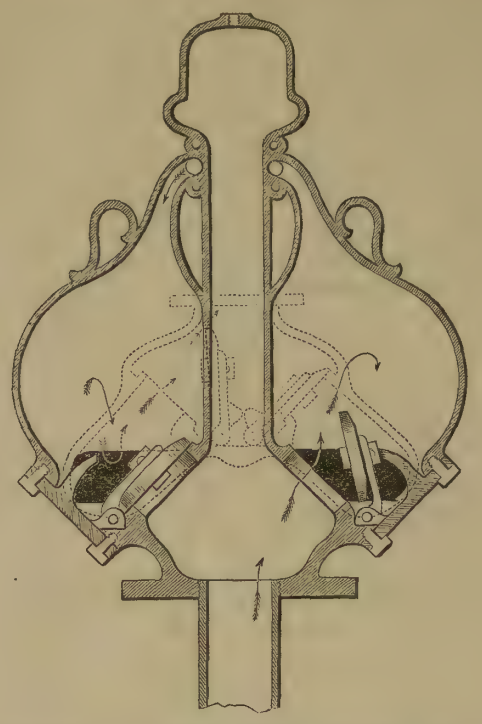
In the accompanying cut, F represents a wrought-iron frame bound by the bands, G G G. When the machine is being operated, these are held together by the links, B B B, which are thrown back, as shown at B, when the work is to be inserted or taken out. The shaft, H, to be straightened, rests against the two movable dogs, C C, and the dog, D, is brought to bear upon the middle and opposite side; then by turning the screw, E, by means of a lever, A, the shaft, H, may be crooked to any extent.

These machines are all made with cast steel screws and nuts; the other parts are wrought and malleable iron and warranted to the maximum size for which they are made. The large machines will straighten iron down to the smallest size, but are not convenient for small sized iron on account of their length. Brackets are sent with each machine so that it can be fastened to a bench for straightening short pieces of iron, either square, flat or round."

These machines have been in use in some of the largest shops in Philadelphia for the last year with entire satisfaction. The sole manufacturers are C. Scofield & Co., Vineland, New Jersey.







THE "AQUOMETER" STEAM PUMP.*

(HYDRAULIC ANNEX, MACHINERY HALL.)

The Aquometer Steam Pump consists of two working-chambers, combined with an interposed pressure-chamber. Its only moving parts are the customary check-valves, and a simple and ingeniously devised steam-valve.

The operation of the pump is simple; so soon as steam is admitted from the steam-pipe, it passes into the neck of the one working-chamber or the other, according to the position of the steam-valve. Entering a narrow space above the water, it mingles with the air within the space, specially admitted thereto by means of small air-valves, and bearing upon the upper surface of the water, forces it out into the discharge-pipe with a pressure nearly equal to that in the boiler. During the movement of the water, the discharge valve, (see dotted lines in the sectional view) is thrown wide open, and the suction-valve remains closed. So soon, however, as live steam reaches the discharge-port, its free escape through the vent thus suddenly opened for it, produces a sudden reduction of pressure within the working-chamber, with the following results: 1st. It allows the discharge-valve to close. 2d. By disturbing the equilibrium of pressure within the steam-valve chest, it produces an instant movement of the steam-valve, so as to cut off the further admission of steam into that chamber. 3d. It simultaneously permits the body of water in the central pressure-chamber to open the suction-valve and cause an instantaneous condensation of the entire volume of steam within the working-chamber, so as to produce a vacuum therein, which will cause it to fill with water from the suction-pipe under the force of atmospheric pressure. As soon as the chamber has thus filled and the suction-valve closes, the momentum acquired by the water flowing up the suction-pipe will operate to fill the pressure-chamber. While the one chamber is thus filling, the steam current operates to force the water out of the opposite chamber, so that a constant flow is produced and maintained in the discharge-pipe.

The steam-valve is supported within the valve-chest upon narrow longitudinal ribs or guides, so as to be wholly surrounded by the steam entering the chest and be comparatively frictionless in its bearings. Moving longitudinally between its guides, it closes against flat seats at either end, to cover alternately the ports opening toward the respective chamber. It is balanced by means of discs, so secured thereto, as that the steam admitted through either port, by a movement of the valve, shall exert a pressure upon the corresponding disc, which will tend, so soon as a reduction of pressure occurs as described within the pump-chamber and on the outer side of the disc, to cause the valve to move and close that port and simultaneously open the opposite one. The flat seats of the valve will, in wearing, naturally remain tight, but if marred or cut by accident, they may be renewed by grinding, without removal if desired; the valve may be removed and replaced by taking off one end-cap and unscrewing the seat-piece. Any dirt or grit which may enter from the steam-pipe should drop between the ribbed bearings, and may be blown out, when required, through a vent, formed centrally in the under side of the valve-chest, and closed by a plug.

The water-valves of the pump are pivoted to loose blocks, which are secured in place by the plates covering the hand-holes through which the valves are inserted. The valves may therefore be readily removed for inspection, and quickly renewed or replaced. For use in water containing mud, sand or dirt, special rubber valves are used and the hinges dispensed with.

This pump thus embraces elements of durability, simplicity and strength. It requires no special foundation for its support, and will operate equally well when suspended by ropes or chains as when given solid bearings.

*Made by the Aquometer Steam Pump Co., No. 10 South Delaware Ave., Philadelphia.

FIRE PROTECTION.

PROTECTION OF OIL TANKS FROM LIGHTNING.

II.

With regard to the construction of the tanks, the first feature that will probably have excited the reader's comment in perusing Mr. Newall's description, is the difference in current practice regarding the material of the roof. In the vast majority of cases, we are told, the roofs of the tanks are of wood. Upon this point, the same gentleman, in the course of his article, makes several remarks which, to say the least, are very suggestive. In one place, alluding to a tabular statement of fourteen (14) cases of destruction—twelve of which were caused by lightning—he remarks, "It may or may not be worthy of attention, in connection with this subject, that not one of the tanks which were inflamed had an iron roof;" and in another place, "I have failed to find a single instance where a wooden-top tank has been struck without fire ensuing."

These remarks, as before said, we have simply interpolated because of their suggestiveness, and without halting to inquire whether the facts upon which they are presumably based would warrant the establishment of general rules, we believe that a moment's reflection will suffice to convince any ordinarily well informed person that, other things being equal, an iron roof is vastly safer than one of wood, and the substitution of the iron in place of wood, in all existing cases where wood is used, and the employment of iron roofs on tanks to be built in future, cannot be too warmly recommended; and measures should be taken to insist upon the universal adoption of this important feature of construction.

Again, the construction of the tanks and covers should be as completely air-tight as possible, in order that the inflammable vapors evolved from the lighter portions of the oil may be confined, and their escape and accumulation about the tanks prevented. It may be found advisable to conduct these vapors some distance away from the tanks, by a suitable conducting pipe, and there consume them.

The purpose of these precautionary measures is obviously to prevent the accumulation of quantities of explosive or inflammable mixtures of oil, vapor and air in the immediate vicinity of the tanks, by which their safety, even under ordinary circumstances, is imperilled. The practice of erecting two or more tanks in close proximity to each other, a practice which, with unaccountable shortsightedness, appears to have been followed in a number of instances, is unwise in the extreme, and cannot be too strongly deprecated, inasmuch as the firing of one is quite sure to involve the destruction of its neighbors. In this, as in the foregoing particulars, a uniform rule should be adopted, establishing a safe minimum of distance (which should not in any case be less than 100 feet) between neighboring tanks.

There are, finally, other points in connection with the location, fixtures, etc., of the tanks, which, although of less importance than those just dwelt upon, may nevertheless contribute materially to the safety or danger of the tanks according as they are properly or improperly carried out in practice. In this connection, we may refer, for example, to the practice which is said to be not uncommon, of employing wooden ladders for gaining access to the roofs—and especially where the latter are of wood—and the still more careless practice of connecting contiguous tanks by means of planks and wooden bridges. The rapidity with which a fire may run up such ladders or across such connecting pieces, saturated as they must be with oil, is doubtless very great, and the additional peril to which tanks are thereby exposed, is so wholly unnecessary, that the commonest prudence will dictate the use of iron for all fixtures of this nature.

There are other points of construction—such as the complete isolation of each of these structures from contiguous buildings or other valuable property, by means of surrounding trenches—which in case of a fire will serve to confine the damage to a single tank and prevent its communication by a flood of burning oil to structures situated near it or upon lower levels. Costly experience, however, has taught the tank owners the value of such prudential measures as shall insure isolation, and we are informed, they are now generally adopted.

Having now indicated what in our opinion were notable defects in the current practice of tank construction, and suggested such modifications of the prevailing methods as appear to be warranted by circumstances, we are prepared to discuss the topic of the proper method of protecting the tanks by means of lightning rods; and here we enter upon a subject about which the most erroneous opinions appear to prevail. Upon this point a paragraph from Mr. Newall's article, from which we made some abstracts in our last, will afford us good material for comment, viz:—

"A few tank owners have placed lightning rods about their tanks; the general fashion being to attach them to poles a foot or so from the sides of the tank and inclining over its top. *Rods thus placed stand convicted of uselessness. A more reasonable arrangement* (the italics are ours) would seem to be this :— Let the rods follow the line of the sides and roof, though *not* in contact therewith; connect their ends above the crown of the roof, and from this point of junction raise a single rod, properly provided with points, to a hight of not less than the semi-diameter of the tank. The rods should, of course, have a section of about an inch ($\frac{9}{10}$ of an inch was the minimum recommended by the French Academy), and should enter the ground to a sufficient depth, and be placed in connection with conducting substances."

Mr. Newall's paper so clearly points out the imperfections in the present practice of tank construction, and his suggested improvements thereon manifested such sound judgment that we have freely made use of them as the basis of the preceding comments. Upon the subject of protection by rodding, however, we believe him to have fallen into serious error, the proper correction of which is the more important, from the fact that his views appear to be very generally entertained.

A brief consideration of the proper function of the lightning rod will enable us to render the justice of the foregoing criticism manifest. The purpose of the lightning rod* is to afford a readier passage for the disruptive discharge called lightning, by means of a better conductor (the rod) than the objects which we wish to protect. The passage of an electrified cloud over the earth involves the accumulation in the earth directly beneath it of electricity of an opposite nature from that of the cloud. The conditions for a disruptive discharge, by which neutralization is effected, will be attained whenever, by the accumulation of electricity, its tension becomes sufficient to overcome the resistance opposed to its equalization, by the non-conducting body of air between the cloud and the earth.

The interposition of a good conductor having a large and excellent earth contact, will facilitate this operation, either silently disarming the cloud by permitting the passage of the current from cloud to earth and *vice versa*; or in case the accumulation is too great, by affording a ready passage for the lightning discharge which occurs suddenly and with prodigious violence. A perfect lightning rod will never be the recipient of a lightning stroke. It should be, theoretically, so excellent a conductor, and in such perfect electrical connection with the earth, as to quietly disarm the electrified cloud as rapidly as the accumulation of electricity takes place. Such perfection, however, it is impossible to attain in practice. We have neither perfect conductors, nor can we secure perfect earth contact, and with the best materials for conductors and the most efficient system of placing them, the electrical accumulation is frequently vastly in excess of the capacity of the rod to neutralize silently, and it occurs with the violence of the thunderbolt. It is imperative, therefore, if the rod is to serve as a protector, that it shall be a better conductor than the object it is designed to protect, and that its earth contact shall be sufficiently large and perfect to permit of the harmless passage and diffusion of the accumulated electricity into the earth, otherwise it will *leave the rod* and take to the neighboring conductor that has the better earth connection. The instances where the lightning has left the rods attached to buildings, and sought out the gas or water pipes—tearing its path through the intervening obstacles, opposed by stone, bricks and mortar, or wood-work—are legion, and force the conclusion that the ligtning rod imperfectly connected with the earth, really invites the danger which it is designed to avert.

In the light of the foregoing considerations, a proper appreciation may be had of the absurdity of the practice which obtains of surrounding oil tanks with small rods perhaps scarcely reaching the ground, and attached to poles placed a foot or two from the tank, and of the equal inutility of Mr. Newall's "more reasonable arrangement" of letting the rods follow the line of the sides and roof, though *not* in contact therewith, connecting their ends above the crown of the roof, and making the cordon terminate in a single rod, &c. In either case we are asked to believe that the electrical discharge will take place along a system of slender rods, when a huge metallic body (the tank) having many thousands of times the attracting and conducting capacity, and a vastly superior ground connection, stands conveniently at hand. If the general practice of rodding tanks "stands convicted of uselessness," the trifling modification proposed by Mr. Newall stands no better chance of success. Both are radically wrong. The probabilities with either system are vastly in favor of the view that the lightning will descend the rods as far as the highest portions of the tank, where it will leave the rod for the tank by lateral discharges, to the imminent danger of destruction of its contents by combustion or explosion. Where the roof is of wood, the danger will of course be greatly increased, although in any case the lateral discharge is highly perilous.

The proper method of rodding such tanks is, undoubtedly, to attach a cordon of rods directly to the body of the tank itself, and to let them pass upwards from the bottom, directly against the sides of the tank, and extend upwards for perhaps twenty or thirty feet above the dome. A system of half a dozen such rods, uniting above the dome in a single rod, would form part of the tank itself, and the great danger to which it is subjected from the lightning stroke would be as completely guarded against as it is possible in the present state of our knowledge to attain. Forming as they would with this arrangement simply a vertical extension of the tank itself, the tendency to lateral discharge from the causes above dilated upon would be practically annihilated, and the electricity would be harmlessly neutralized by diffusion throughout the metallic body of the tank.

Where this system of rodding is combined with the improvements in point of construction detailed at some length in what has preceded, the tank owner and the fire-underwriter may rest under the assurance that everything has been done that intelligent and judiciously directed foresight can dictate to protect these reservoirs of inflammable material from destruction by lightning. W.

*For an excellent popular discourse upon lightning rods, in which the subject is most correctly and lucidly treated, see Jour. Frank. Inst., lxiv, 132 *et seq.*, Art., Lightning and Lightning Rods, by David Brooks.

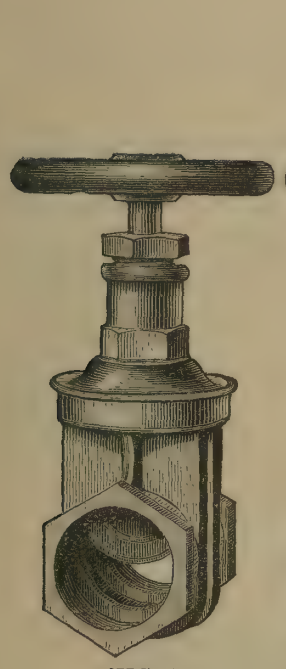


FIG. 1.

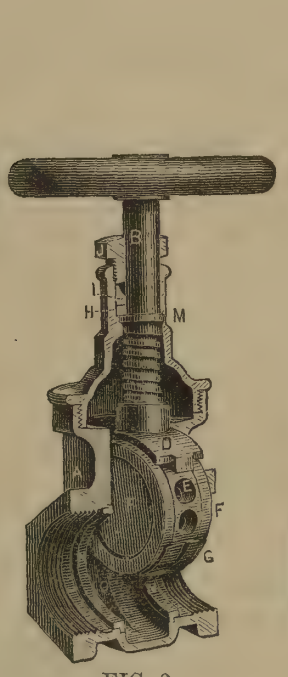


FIG. 2.

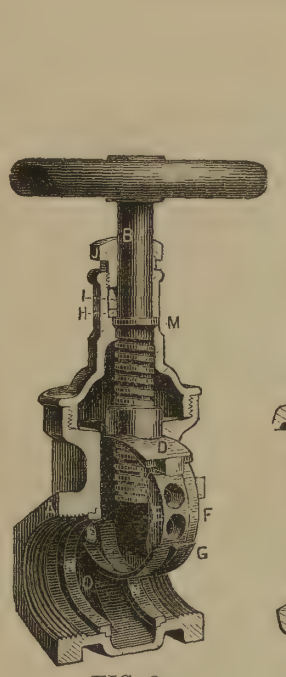


FIG. 3.

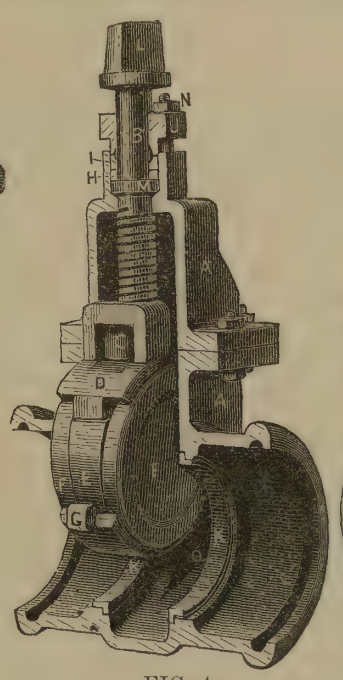


FIG. 4.

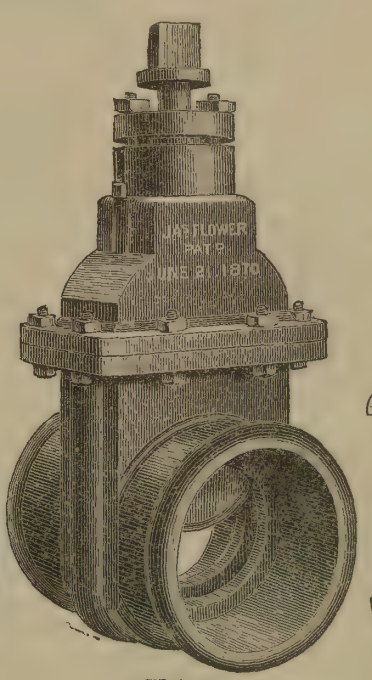


FIG. 5.

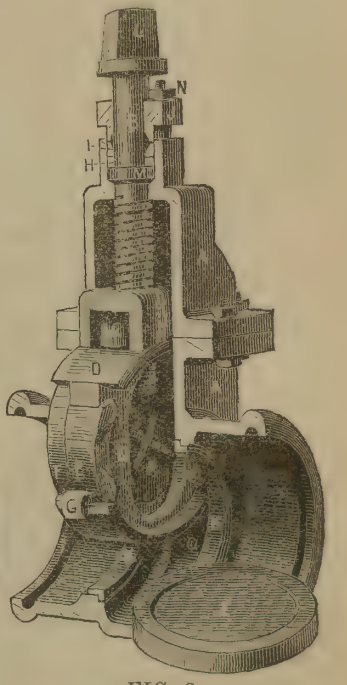


FIG. 6.

FLOWER'S DOUBLE-FACED, LOOSE DISK STOP VALVE.

The makers are Messrs. James Flower & Brothers, Detroit, Michigan, and they claim for this valve :

"1st. A straight open passage-way, the full size of the pipe.

2d. It is double-faced, with two loose disk-valves setting loose in a cage, allowing the disks to adjust themselves to the valve-seats.

3d. The valve-seats are not parallel, but divergent, and allow the disks to form a wedge-shape; these last are held to their seats by equalizing bars in the cage, which bear against the backs of the disks when closed.

4th. The disks do not drag or rub on the valve-faces in working.

5th. The valve-seats being divergent, and the disks loose in the cage, there is no sticking when opening under pressure.

6th. All parts are made interchangeable."

Figure 1 is an outside elevation; and figures 2 and 3 are vertical sections of the brass valves, for steam or water purposes, in which A represents the body of the valve; F F the valves partly opened; N (or K in figs. 5 and 6), the valve-seats inclined to one another; D the cage which carries the disks F F, and which are loose in the same; E is the equalizing bars—one on each side of cage D, which allows the valves or disks F F to seat themselves truly on the seats N (or K in figs. 5 and 6); the cage D, and the disks F F, are elevated or depressed by the square threaded screw B, which in the iron-body valves, shown in figs. 5 and 6, works in a loose brass nut C, contained in a chamber cast on top of cage D. The stem B has a collar, M, cast upon it, which is tapered and ground to a steam-tight joint, and has a brass "thrust collar" H, which fits on a shoulder in the stuffing box, allowing the stem to be loose enough to rotate, but not to lift. Upon this is placed a "patent metallic packing," I, in the hollow of which is wound a little hemp; the gland J is then screwed down, and everything is secure.

In iron body valves, figs. 4, 5, and 6, the gland J is screwed down by the bolts for that purpose, one of which is shown at N. G is a short horn cast upon the cage D, and traveling in a groove O, (a portion only of which can be seen in the figure), and which is cast in the body, A, of the valve. The exterior can be seen in figs. 1 and 5. In figs. 3 and 6 the front disks, F, have been removed, the better to show the construction of the cage D.

PROGRESS IN SCIENCE AND THE ARTS.

CENTENNIAL NOTES.

COMBINED WOOD WORKING MACHINE.

The Greenwich Machine Company, of Greenwich, N. Y., shows at A-37, Machinery Hall, a combined wood-working machine possessing some novel features in the driving mechanism; and which is also adapted to a wide range of uses, with but little apparent difficulty of adjustment. Fig. 1 shows the machine as constructed with a wooden frame; an iron frame machine is also exhibited. The main shaft carries, as desired, a circular saw, a planer head, moulding heads, or a boring tool. The table, which is sectional and can be inclined at any angle in the saw plane, can be quickly adjusted to suit the varied requirements of sawing, boring, or planing. The planer head is supplemented by proper feed-rolls and pressure-springs. Surface moulding or other work of a similar character is within the range

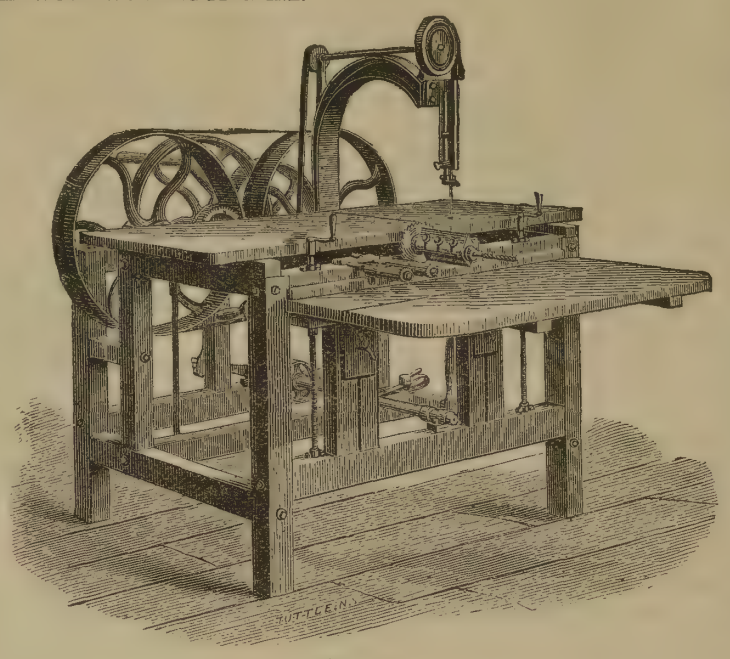


Fig. 1.

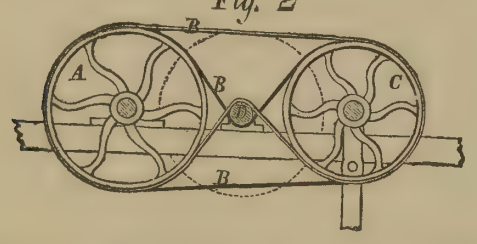
The jig saw is carried by the arm seen above, and has a positive motion and an adjustable rake; it is supplied with a simple and effective blower.

The machine will take 8 inches thickness under the scroll-saw, and plane or work mouldings up to 6 and 8 inches wide and 12 inches thick. Its capacity for circular sawing and boring depends of the machine.

on the size of saws or bits used. The machine may be driven by power or even by hand.

This leads us to a consideration of the driving gear, patented by Mr. Weaver as a new mechanical movement, and represented in Fig. 2.

Fig. 2



The small center pulley is that upon the saw arbor; the large driving pulleys are double, and from each runs a belt holding the middle driven pulley in close frictional contact; the two belts opposing each other in their pull upon the shaft, and hence, according to the claim of the inventor, greatly diminishing the journal friction. One of the large pulleys is so arranged as to permit of the belt tension being varied at will to suit the requirements of the work; the lever effecting this change being seen in the figures.

By this arrangement the transmission of power, and its distribution to the different parts of the machine, are effected without the weight and expense of a complicated series of belting and countershafting; the manufacturers claiming that by the ordinary system of transmission fully fifty per cent. of the driving power is wasted in slipping, overcoming journal-friction, &c. G.

WEAVER'S FOOT-POWER COMBINED SCROLL AND CIRCULAR SAW.

The cut shows this machine, which has a cast-iron frame, occupying but little space. The strain is put upon the saw by means of right and left hand screws, which draw the ends of the levers together or slack them up as the saw comes up.

The scroll saw is adapted to any work not exceeding 7 inches in thickness; and the blade is steadied by a steel bearing at its back. The treadle has much less rise and fall than usual. Made by the Greenwich Machine Works, Greenwich, N. Y., and shown in Machinery Hall, column A–37.

ROBERTS' PAINTING MACHINE.

[*Column B*—11, *Machinery Hall.*]

In the British Department of Machinery Hall is an unobtrusive but ingenious little machine, which has for its object the painting of laths or strips of wood, or iron, evenly and thoroughly on both sides and on the edges. The inventor is Mr. Wm. Roberts, of Bootle, Liverpool, England

There are two feed rollers, the lower of which is grooved spirally and has at each end a paddle wheel with floats or buckets so arranged as to dip into a tank of thin paint, and, carrying up the liquid, throw it on the rollers and on the strips which may be fed between them. The strip or lath is thus coated or washed with paint on both sides; but it next passes between two long brushes, which distribute the color more evenly if desired, and remove and return to the tank below any slight excess of paint. The strip passes out uniformly coated; the work being equal to or better than hand work.

The speed of the small machine exhibited, and which takes in a lath 3 inches wide and 18 inches thick, is estimated at 6,000 running feet (or say 600 laths) per hour, on both sides and both edges; requiring the attention of one man and two boys. The rollers and the brushes have a vertical adjustment by means of screws. A fly-wheel serves to apply and steady the power.

The machine is very easily run, and is neat in its operation, being of course much less wasteful, and scattering less paint, than the hand process. Our favorable opinion of the machine is strengthened by testimonials from England.

The same principle may be applied to painting doors or other surfaces, shingles, mouldings, corrugated iron, window shades, etc. G.

BENT WOOD FURNITURE AT THE EXHIBITION.

[Exhibit of Messrs. I. & J. Kohn, of Vienna—Austrian Section, Main Building.]

The visitor to the Exhibition who has entered the Austrian Department, in the Main Building, must have observed and admired the exhibit which heads this notice, and which is beyond question one of the most attractive of its class in the building. The exhibit, down to the smallest item, is admirable. The articles displayed, which include chairs, tables, &c., of various sizes and designs of bent wood, have a most pleasing and artistic design and high finish, and are at the same time substantial; thus realizing the best expression of art, beauty of design and utility.

This class of furniture is extremely popular in Europe, and the sight of the Messrs. Kohn's exhibit, will recall to many beholders pleasant memories of the cafés and gardens of the Continent. In this country, we believe, it is but little known, but if properly introduced, its popularity here, as abroad, will be assured.

It may not be without some interest to our readers to describe in brief the method of treating the wood in the manufacture of the class of goods displayed by the Messrs. Kohn.

The wood employed in the production of the bent wood furniture, is the beech that flourishes on the slopes of the Carpathian Mountains, and which is admirably adapted for this purpose by reason of its fine texture. From the great amount of this wood that is consumed in this special industry, it is obvious that it cannot be selected from those portions of the trees that are free from branches, and to bend wood of this description so that it shall not split, is a task that can only be accomplished by an expert workman.

The practice of the Messrs. Kohn is described to be about as follows: The wood to be utilized is cut in the forest, by means of easily transportable steam saw-mills, directly into strips, of the dimensions that the separate pieces of the furniture have in the rough. These strips are then conveyed to the factory, where a considerable quantity is simultaneously subjected to the action of steam. The wood remains in the steam, both until it is thoroughly saturated therewith, and the vegetable juices largely removed. In this condition the wood is extremely flexible, and when dried is far more durable than when in its natural state, inasmuch as the operation just detailed washes out all the soluble constituents and leaves the unalterable cellulose, or woody fibre, behind. After steaming also the wood is more easily worked.

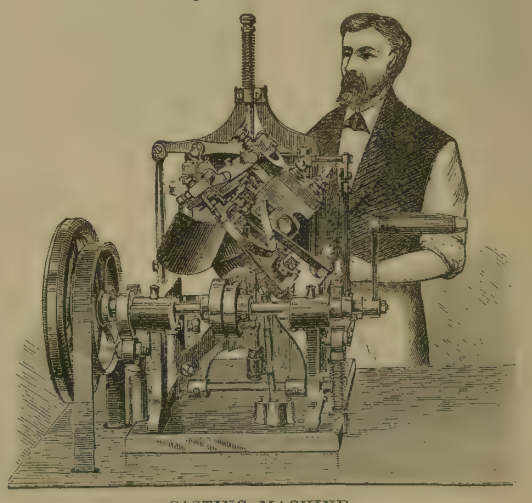
After steaming, each of the pieces is brought into an iron form, having the shape which the stock is finally destined to possess, and allowed to remain there until quite dry. The several subsequent processes of joining and finishing, involved in the union of the bent sticks into the completed article of furniture, need not be described.

The advantages possessed by furniture constructed of bent instead of sawed pieces may be briefly summarized as follows: The bent wood furniture possesses superior strength and durability, with the smallest quantity of material, which permits of that admirable combination of lightness with elegance of design which characterizes this class of furniture. The widest scope is allowed for the exercise of artistic talent, since the bending process permits of the production of the most varied and intricate patterns.

We have already had occasion to refer prominently to the decided advantages of bent wood over sawed timber for ships, [*vide*, this journal, vol. ii, page 47; ART. Machinery for Wood Bending.] W.

THE FIRST TYPE FOUNDRY IN AMERICA.

Among the most noteworthy displays in Machinery Hall may be placed the exhibition made by Mackellar, Smiths & Jordan, the proprietors of the oldest type foundry in America, and the leading foundry in the world. Within a space of three hundred square feet is comprised an assemblage of articles that possess a peculiar attraction for intelligent persons,—the glamour that has always enveloped the invention of the art of printing seeming still to throw a mysterious interest around every department of typography. This is daily evinced by the eager crowds that hang around the enclosure devoted to this collection of type founding apparatus. The railing is composed of immense types showing the name and location of the house and foundry. Within are two casting machines,



CASTING MACHINE.

built by the firm, of exquisite workmanship, heated by gas and running by steam-power. At every revolution the mould comes up to the spout of a force pump; a sufficient amount of liquid metal is forced into it, and it at once flies back, and, as it were opening its mouth, it expels a fully formed type, at the rate of from 90 to 180 per minute. How wonderful is the pro-

gress in type-founding any one may see who inspects the type-moulds (displayed on a table near by) which were in use in this establishment in the last century—this house dates from 1796—when the workman held the mould in one hand, while with the other he dipped up in a spoon a small amount of hot metal from a pot and poured it into the opening of the mould, afterward giving the mould a quick upward throw to force the metal to the bottom of the mould. This ancient mould, called the "ring-tailed mould," was in universal use till Archibald Binny (who, with James Ronaldson, was the founder of the house) invented an improvement by which the work of the casters was expedited by fifty per cent. This improved mould, which is shown on the same table, was superseded in 1845 by the effective machine now at work in Machinery Hall.

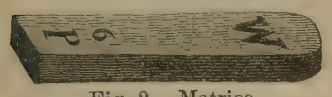


Fig. 2.—Matrice.

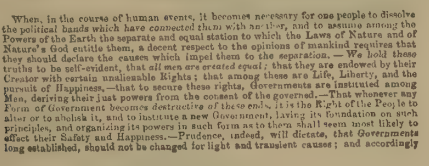
Fig. 3.—Steel Punch.

Fig. 2 shows a copper matrice or mould-face, with a letter in *intaglio:* Fig. 3 shows a steel punch (with a letter in relief and reversed) used in punching the matrices. These punches must be cut with the utmost accuracy and care by artists of the highest skill, and earning high figures. At present, Delacroix and some other skilled engravers expedite their work by cutting the original letter in relief in type metal, and forming the copper matrice by electrotypy.

Near by, is a machine for rubbing type, invented in this establishment, and another for "kerning" type, as also a dressing bench, all evincive of the finest mechanical skill.

And here is a case containing specimens of a few of the immense varieties of plain and fancy printing types made in this foundry. The smallest type may be almost called microscopic, as about 4,600 type of the letter (*i*) go to a pound.

Herewith we give a specimen of this smallest type, *brilliant.* It is impossible, even with our excellent Hoe presses, and the pressman's most careful work, to bring out these letters perfectly; the finest cut ink, hard paper, and most careful jobwork being required.



When, in the course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the Powers of the Earth the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.—We hold these truths to be self-evident, that all men are created equal; that they are endowed by their Creator with certain unalienable Rights; that among these are Life, Liberty, and the pursuit of Happiness,—that to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed.—That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute a new Government, laying its foundation on such principles, and organizing its powers in such form as to them shall seem most likely to effect their Safety and Happiness.—Prudence, indeed, will dictate, that Governments long established, should not be changed for light and transient causes; and accordingly

The sizes go up by regular gradations until a single letter will weigh a pound or more. There are crochet type for patterns of ladywork, and music type, the most perfect yet invented. And all manner of conveniences for printers' use, made in brass and type-metal,—borders, ovals, circles, slotted corners, printing blocks, galleys, &c.—so handy and so numerous, that if Ben. Franklin's ghost should happen to drop in, it would be utterly nonplussed and astounded at the multiplicity of facilities for the modern printer which even the old man's practical philosophy had never foreseen.

And there are the wonderful Specimen Books, displaying the typographical wealth of material of this immense establishment—books which, in the wording of its lines and paragraphs, have inaugurated a unique and curious type-founder's literature. The larger volume was several years in going through the press and involved an outlay of almost fifty-thousand dollars, We can endorse the makers' claim that its peer is not to be found in the world.

There is probably not an exhibition in the Exposition halls that shows so strikingly as this the contrast between the tools and modes of operation of 1776 and those of 1876.

The machine-room of this establishment is completely furnished with the finest tools and machinery for building and repairing its own machines, and for the production of brass rules, ovals, circles, and other furnishings for printing offices.

Artistic punch-cutters are kept constantly at work in the production of plain and ornamented types, of designs so elegant and popular that most of them are reproduced in Germany and other foreign countries. Since the enactment by Congress of a law protecting new designs of printing type against piratical reproduction in the United States, this house —with other American founders—has evinced great activity in bringing out types of exceedingly beautiful styles, and has thus enabled American printers to resist the encroachment of lithographers on the legitimate domain of typography.

This house has published for more than twenty years a periodical entitled *The Typographic Advertiser,* which is sent to all the printing offices of North America, and circulates extensively in South America, Europe and Australia, and in some portions of Asia and Africa. This periodical is the oldest of its class in the world, and is still under the charge of its original editor, the senior member of the firm.

Binny, one of the founders of this establishment, retired about twenty years after, and was succeeded by his partner, who gave place to his brother Richard Ronaldson. Richard was followed by L. Johnson and G. F. Smith. Smith retired, and Johnson soon after took into partnership Thomas Mackellar, John F, Smith and Richard Smith, the two last named being sons of his former partner. On Mr. Johnson's death, the three survivors associated with them Peter A. Jordan, and the firm is now known as Mackellar, Smiths & Jordan.

MINING, METALLURGY AND MINERALOGY.

The Lake Superior Silver and Gold Discoveries.—Two letters received in this city during the week represent that highly important silver and gold discoveries have been made in the vicinity of Arthur's Landing, on the north shore of Lake Superior, about two hundred miles north-east of Duluth. These reports are trustworthy, and intimate that a few days ago, near what is known as the Thunder Bay Mine (which has been yielding from $2,000 to $3,000 to the ton of rock), a miner dropped down upon an outcropping of crumbled quartz, all bristling with native silver. At last accounts they were gathering the rock in carts and packing it for the mill. It was thought it would yield from $3,500 to $5,000 to the ton.

Another discovery has likewise been made at a new opening called the "17 K" mine, recently bought up by some Boston men who have a large force of workmen employed on their premises. In consequence of these silver discoveries, and also of some rich gold quartz, there is a large amount of mining excitement; indeed, so great is the interest aroused, that the Canadian Pacific Railway (now building from Thunder Bay northward) is almost forgotten, nobody apparently caring whether it goes through or not.—*St. Paul (Minn,) Pioneer Press.*

CHEMISTRY, PHYSICS AND TECHNOLOGY

Re-discovery of a Lost Planet.—The astronomers of Europe are just now excited by the re-discovery of Leverrier's planet, Vulcan. Some twenty years ago the great French astronomer announced that certain perturbations in the orbit of Mercury could only be accounted for by the existence of another planet still nearer the sun; even as the perturbations of Saturn had enabled him to discover the planet Neptune.

Within three years after Leverrier's announcement, a French observer, Dr. Lescarbault, detected Vulcan in his transit across the sun's disk; but inasmuch as he has not been seen again since then, most savans have begun to doubt whether he was ever seen at all. But the latest Parisian journals inform us that two eminent astronomers at the Observatory in that city—M. Porro and M. Wolf, of Zurich—have just found Vulcan during his transit as before.

It is not stated whether their observations were sufficient for the precise calculation of the elements of the planet. Kepler's law, however, would reduce the time of Vulcan's revolution around the sun to about a month. This youngest of the planets must swim in a sea of almost unimaginable light and heat, and be uninhabitable by any form of life known to us.

Electric Lighting in France.—According to the *Moniteur Industriel Belge,* the method of lighting railway termini, workshops, &c., with electric light from Gramme machines (on M. Lambotte's system) is coming rapidly into favor in France. M. Lambotte made trial of various motors, and at last had recourse to a small compressed air engine of two-horse power, having a pulley one metre in diameter, and a very heavy fly-wheel. This works regularly; but as with all motors, when the exterior circuit was broken (by rupture of wires and consumption of carbon points) the magnetism ceased and the motor raced. M. Lambotte remedies this by means of a hammer acting automatically. In the use of a dynamo-electric machine, the exterior circuit has to be arranged with great precision. Should this be too resistant, more motor force is necessary to obtain the maximum of light, and besides, the circuit is *heated.* If it be not resistant enough, less force is needed; but then the Gramme machine is itself heated, sometimes so much that one cannot hold the hand on it. M. Lambotte inserts in the circuit a galvanometer and a thermometer. The former is an ordinary instrument with a long aluminium needle. The motor and the Gramme machine being constant in speed, the needle maintains the same deflection. Should there be variations in speed, the galvanometer indicates them at once; it indicates too, if the circuit be broken; or if there be contact of the two wires going to the lamp (the resistance then being diminished). It has happened with the Gramme, that the engine moving with ordinary speed, and the galvanometer showing the usual deflection, yet no light is got. There must then be a fault in the circuit; and it is probably found in the moving ring, or the bobbins touch the central piece of soft iron. The galvanometer placed near the engine-man, is a control apparatus of the nature of a manometer. The thermometer has the same object. With a constant current, the maximum of heat is fixed. If too much current pass, the thermometer indicates it immediately. It is a simple electro-magnet, in the interior of which is placed an ordinary thermometer. Lighting, by means of the Gramme machine, has lately been adopted by the Compagnie Du Nord, for the platform of the station of La Chapelle, and the Paris-Lyons-Mediterranean Company is also adopting it in some of its stations. [*Telegraphic Jour.,* iv, 231.

The Possibility of Securing Records of Sound by Means of Photography rests upon the sensibility of flames to sound vibrations. M. König, of Paris, has lately constructed an instrument of the most simple character which renders visible the vibrations of any sounds uttered in its presence. The instrument consists simply of a burning gas-jet, the tube of which has at one spot an orifice covered with an elastic membrane. This membrane or drum is the means of influencing the flame. A person speaking or singing against the drum at once works upon the flame in a most extraordinary manner; as the sounds are uttered one after another, the flame takes up different forms, and these forms reflected in a revolving mirror give rise to a continuous light curve, which is governed by the sounds that are pronounced. So that a speech or song would be represented by a series of visible curves.

M. König has already sketched some of these curves as he has seen them, and it will therefore be but going a step further to photograph them. To do this, Professor Vogel points out, it would simply be necessary to provide the revolving mirror with clockwork, so that it might move at a given rate, and to employ a gas flame which is sufficiently actinic to produce an instantaneous impression upon the sensitive plate. For instance, cyanogen, although it has never yet been used in photography for such purposes, Dr. Vogel thinks might be employed with advantage, as it would probably give a very vigorous image; but this would, of course, be a matter of experiment.

That some practical results may be secured, therefore, in the matter of recording sounds by photography, there seems a great degree of probability, and if the flames can only be made to alter their shape sufficiently, records even of a delicate nature might parhaps be secured. We do not suppose, however, that the time will ever come when the staff of reporters at the House of Commons will be replaced by a sensitive flame and a camera. A monotonous curve would in that case represent brilliant and prosy speakers alike, and the innovation would at once get over that much vexed question of "strangers," which is so often cropping up. Our legislators might hold their debates in private, without being influenced by the knowledge that every word they uttered is watched and weighed by galleries of spectators. The little gas tell-tale would be forever doing its duty faithfully and impartially, and when the house rose, all the eloquent and fiery speeches would be found recorded, sound for sound, as they were uttered, without any adornment from the hands of the reporters. [*Photographic News.*]

The Amber Industry of Germany.—The activity of this industry may be inferred from the statement that it is made upon reliable authority, that twenty-two dredges, two tugs, one hundred barges, manded by one thousand hands are employed. The area of the amber fields is quite large, and the yearly income derived from the issuing of privileges nets the Government over 70,000 thalers.

EDITORIAL CORRESPONDENCE.

COAL FOR SOUTH AMERICA.—A WAY TO IMPROVE HARD TIMES AND EXTEND PHILADELPHIA COMMERCE.

To the Editors of the Polytechnic Review:—Sirs: With regard to the statements in our daily papers, that one of our coal companies intended to establish a line of ships to carry coal to the West Indies and South America, it might be of general interest to hear something about the feasibility of such a project. I have made a careful calculation, and find that with steamships of proper size and construction, a freight of four dollars per ton from Philadelphia to Pernambuco, about four thousand miles, would pay all expenses, including repairs, insurance, and depreciation fund, harbor dues, etc., and six per cent. interest on cost of ships. This would be without counting any freight coming back, the ships returning with water balast. If return cargoes could be had their freights would nearly all accrue to net profit. I have reliable information that the Pacific Mail Steamship Co. pays from $5 to $7 per ton to sailing vessels to take coal to the Isthmus of Panama for their steamers. This is only about one-half the distance mentioned above. What an advantage the building and running of such a fleet of ships would be to Philadelphia, need not be enlarged upon, and those of our capitalists who are enterprising enough to take this matter up will deserve the thanks of the community and make a nice dividend besides.

Respectfully, J. HAUG, C. E.

Philadelphia, Sept. 20th.

INDUSTRIAL.

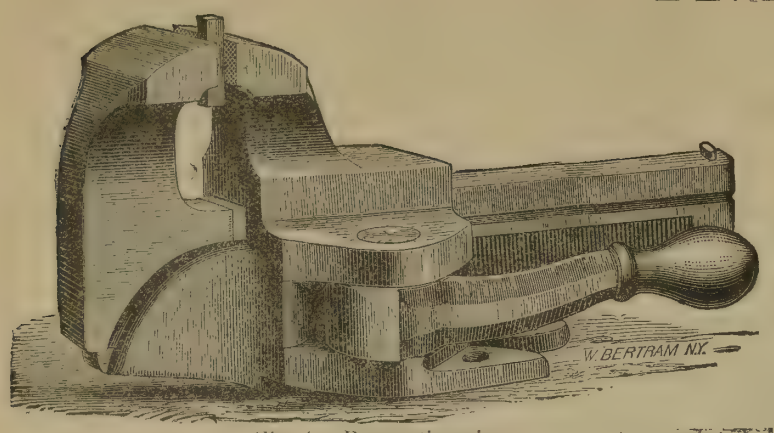


Fig. 1.—Perspective view.

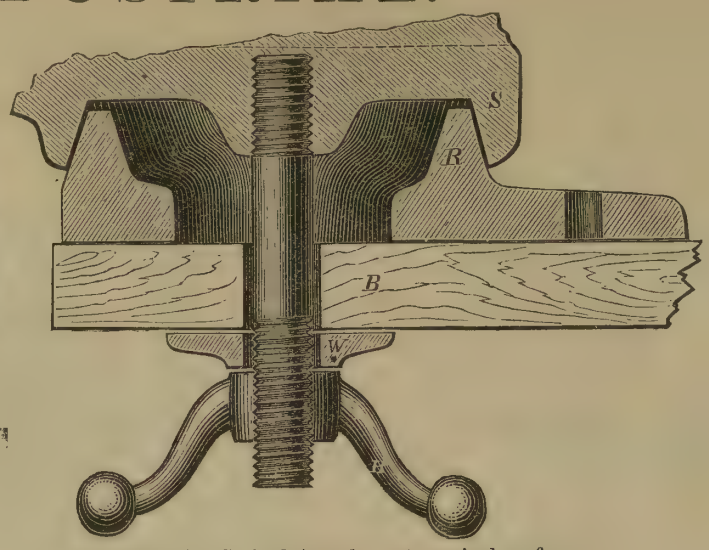


Fig. 4.—Swivel Attachment, conical surfaces.

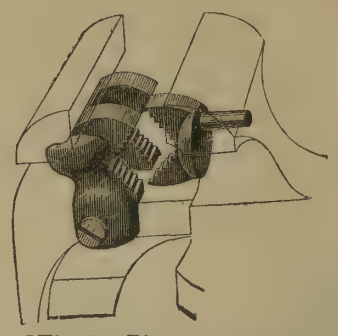


Fig. 6.—Pipe Attachment.

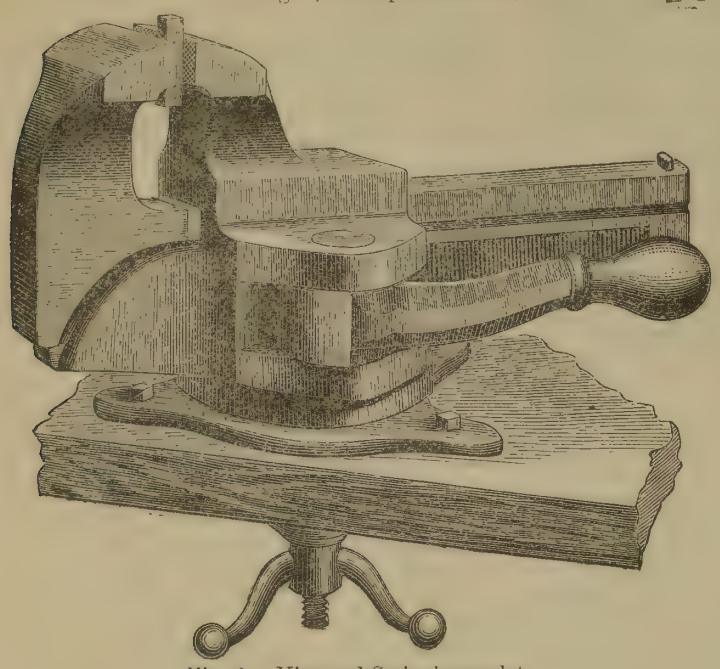


Fig. 2.—Vise and Swivel complete.

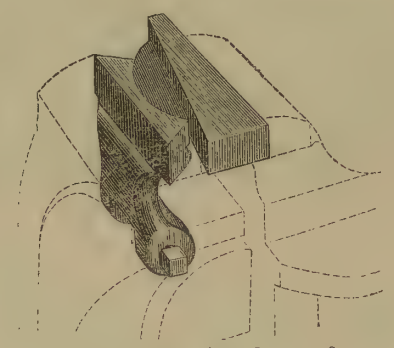


Fig. 5.—Taper Attachment for irregular work.

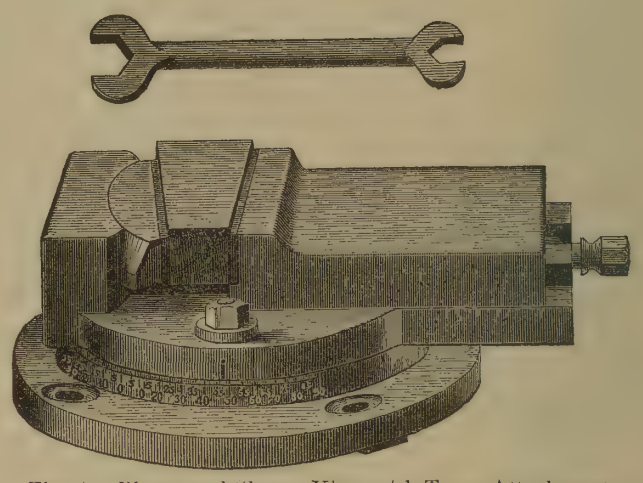


Fig. 8.—Planer and Shaper Vise, with Taper Attachments.

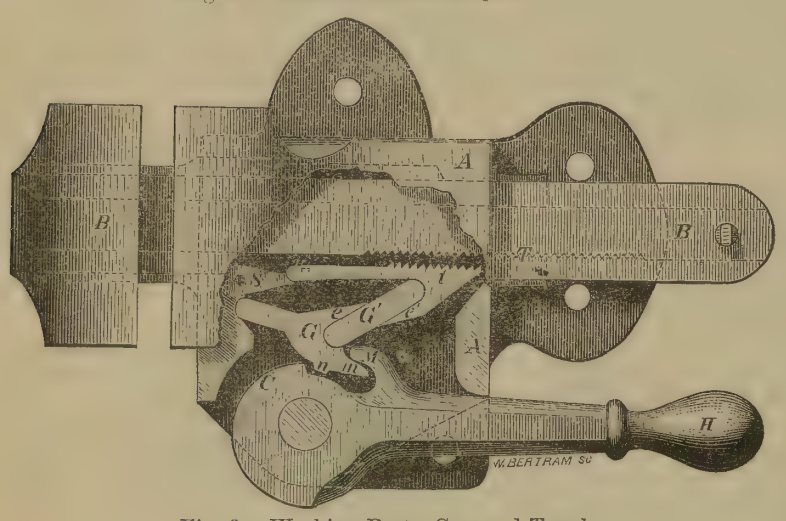


Fig. 3.—Working Parts, Cam and Toggle.

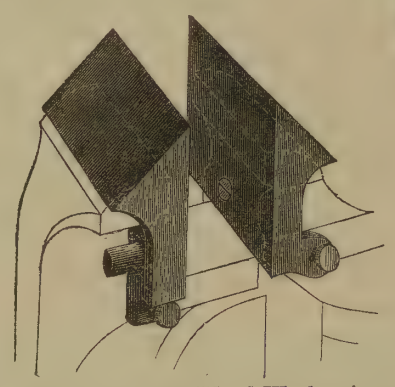


Fig. 7.—Coach, Wood-Workers' or Harness-Makers' Attachment.

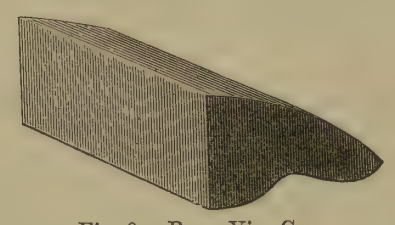


Fig. 9.—Brass Vise Cap.

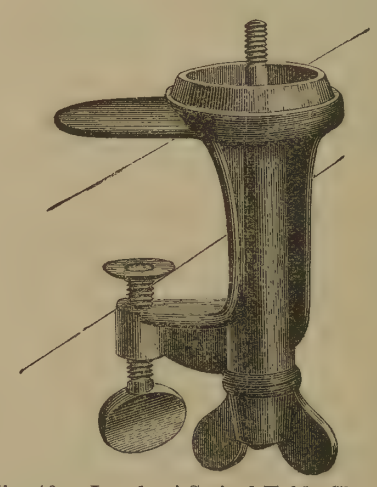


Fig. 10.—Jewelers' Swivel Table-Clamp.

THE STEPHENS' PARALLEL VISE.

This very ingenious and useful workshop appliance, shown very clearly by the accompanying engravings, is not an "improvement" on the old screw vise, but works on an entirely different and very novel principle.

Fig. 1 represents a perspective view. Fig. 2 represents a perspective view of the vise and swivel complete. Fig. 3 shows a vise with top removed, to show its working parts. It consists simply of a toggle, *GG*, and tooth bar, *t*, held together by a spring, *S*, all worked by a cam, *C*, and hook, *M*, on the handle, *H*.

A steel rack, *T*, is inserted in the sliding bar, *B B*.

The jaw slides against the thing to be held, and one pull of the handle fastens it perfectly secure.

At the first start of the handle outward, the hook, *M*, slips from the tooth, *m*, and the spring, *S*, draws down upon a hook at *U*, firmly setting the tooth bar, *t*, against the rack, *T*; as the handle is pulled further outward, the cam is brought to bear against the ridge, *n*, nearly straightening the toggle, and forcing the movable jaw with great power against the thing between the jaws. The slightest back-motion frees the work.

The swivel vise has a conical bearing, which allows the vise to be turned around in any direction, to get a better light upon the work, or to get it in a handier position, and yet is held so firmly that it cannot be driven around, and never can wear or work loose. The upper cone covers the lower one, so that filings, &c., cannot get between the bearings and wear them unevenly. Fig. 4 shows a vertical section of the swivel.

The taper attachment (Fig. 5) adjusts itself to any required "bevel," and as the pressure is always direct and equal on every part, there is no strain upon it, and therefore it is not liable to get out of order; and as it is entirely independent and distinct, it does not weaken the vise, as every other device heretofore made for the same purpose on other vises does.

The "pipe attachment" (Fig. 6) holds pipe, rods, bolts, &c. perfectly firm, so that a screw thread may be cut upon them without the work slipping or giving way.

The "wood workers' attachment" (Fig. 7) has a very broad and deep surface, so as to hold any material firmly without marring it, and readily adjusts itself to hold beveled work, such as coach-makers, stair-builders and others often have, and need to hold firmly in the prosecution of their business.

Fig. 8 shows Stephens' planer and shaper vise, with self-adjusting taper attachment, for holding any kind of bevel, taper, or irregular work. The convenience of its graduated base will be appreciated by practical and accurate workmen.

Fig. 9 shows a brass vise cap. These caps fit and keep their places, and never fly up nor drop off.

Fig. 10 shows the Stephens' swivel vise on the table clamp. 5½ and 6½ in. vises are made with extension handles.

Take an ordinary vise with a screw 1⅛ inches in diameter, having four threads to an inch, and open it one inch. The threads of the screw *rub* along its nut or bearing the *entire length of the thread* on one inch, that is 14 *inches*, for one thread around a screw 1⅛ inches in diameter is 3½ inches long; therefore, four threads, the number on one inch of the screw, will be four times 3½ inches, equal to 14 *inches;* or, on the other hand, the toggle of the Stephens' Vise moves only one-64th of an inch; but we have seen that the screw rubs 14 inches, that is eight hundred and ninety-six sixty-fourths inches; or a distance eight hundred and ninety-six times greater than the motion of the toggle of the Stephens' Vise.

To open a screw vise 8 inches requires 25 turns or revolutions of the handle; and to close it 25 turns reverse, making fifty turns in all. Whereas, Stephens' Vise is opened eleven inches and shut again in less time than it takes a workman to make one turn and back on any screw vise. The saving of time and labor is hence *fifty to one.*

The makers claim that their combination and arrangement of the principles and powers of the cam, lever, toggle joint and ratchet, is the simplest and most powerful device yet made for firmly holding work while shaping, dressing and finishing it; and that it is not simply an improvement, but makes an entire revolution in vises.

They also claim that their vise opens further, holds firmer, is heavier and more durable than any other; that its movable jaws cannot twist from side to side; that there is no wear to the racks, for they merely engage and travel together without *rubbing.*

In their circulars, the manufacturers say: "In case of breakage to any part of a vise, never send it to us; write what the trouble is, stating size and number of the vise, as marked on top of the back jaw, and we will send a duplicate part; for every part is made to gauge, and interchange, and sure to fit;" but the apparent liberality of this offer disappears in view of another statement, that they "have never yet heard of any part of Stephens' Vise wearing out."

This vise and its attachments are exhibited by Lewis L. Davis at the Centennial Exhibition, Sec. B. 6, Col. 40, Machinery Hall, near the great Corliss Engines. Or, address Davis & Converse, 1½ Park Place, New York City.

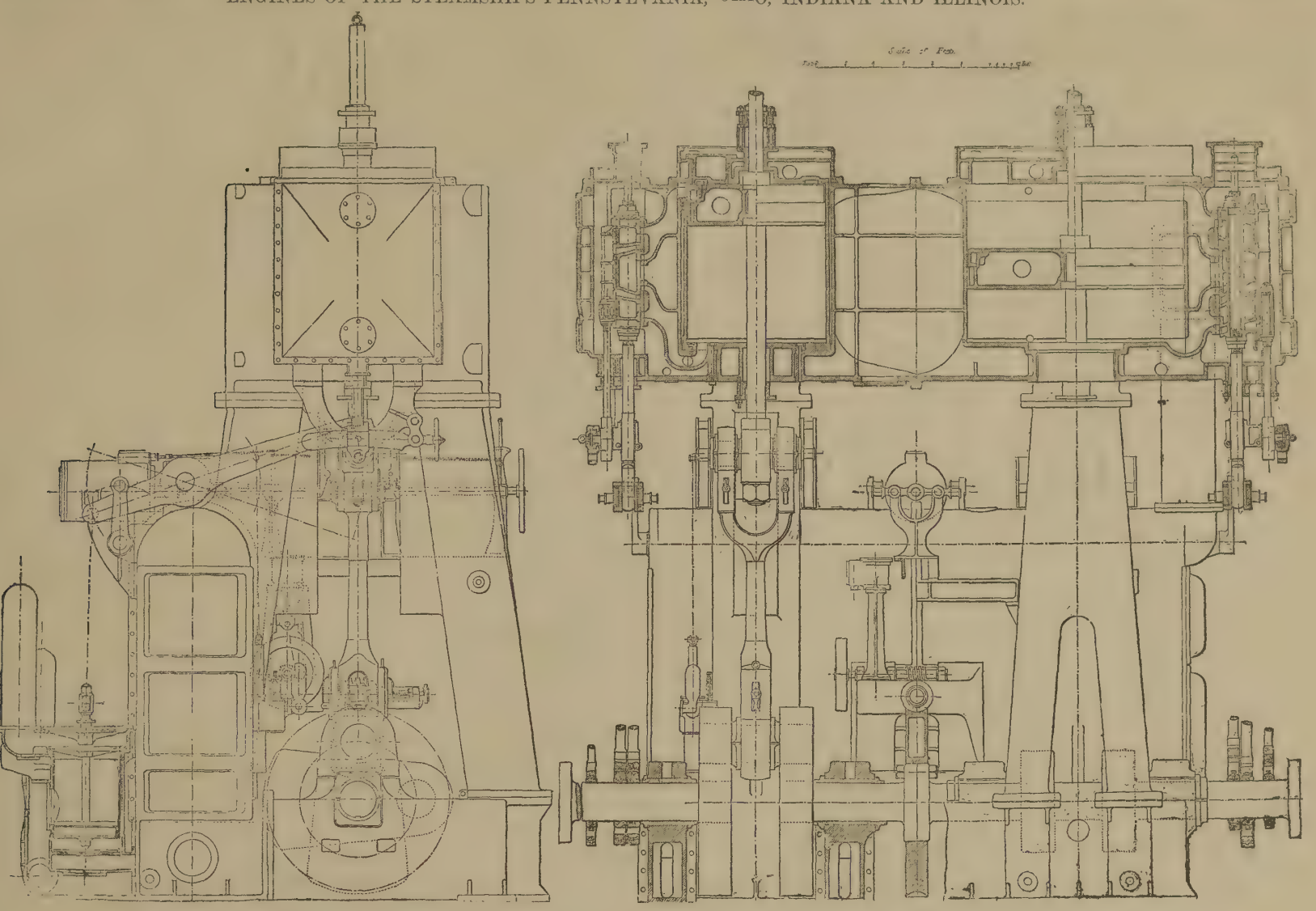
THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, SEPTEMBER 30, 1876. NO 13.

ENGINES OF THE STEAMSHIPS PENNSYLVANIA, OHIO, INDIANA AND ILLINOIS.



THE AMERICAN STEAMSHIP LINE.

The hulls and engines of the American Steamship Company's four vessels—the Pennsylvania, Ohio, Indiana, and Illinois—were designed and built by the W. Cramp and Sons' Ship and Engine Building Company, Philadelphia, and are all of the same model and plan.

The Pennsylvania commenced running between Philadelphia and Liverpool in May, 1873, and was followed the Ohio in August, the Indiana in October following, and by the Illinois in January, 1874, since which time all have been regularly engaged upon the same route. The vessels are 355 ft. long over all, 43 ft. moulded breadth, and hold moulded 33 ft. 6 in. Their gross tonnage is 3030 tons.

The engines which we illustrate by a two-page engraving this week, as well as by a plan on the present page,* are independent, compound, and surface condensing, with the crank set at right angles. The cylinders are 57¼ in. and 90⅛ in. in diameter respectively, and the stroke of pistons is 4 ft. The main slide valves are on the outside of the high and low-pressure cylinders, which are both enclosed in a jacket connecting them together, and forming a receiver. The high-pressure cylinder is also steam-jacketed, but the low-pressure cylinder is not. The pistons are 16¾ in. deep; the rod for the high-pressure cylinder is 8 in., and that of the low-pressure 8½ in. in diameter, and both are carried upwards through the cylinder heads. The crossheads are of wrought iron, with cast-iron slides bolted to their ends. The main slide valves have double ports, each is fitted with an independent cut-off valve on the back, no provision being made for counterbalancing the pressure on the valve faces. The weight of the main valves is counterbalanced by the steam pressure in a cylinder on the top of the steam chest. Both main valves are driven by motion of the double bar link type.

The engines are reversed by direct-acting steam gear, the reversing cylinder being 20 in. in diameter, with a slide valve on top, which is thrown open by hand, and closed by the motion of the piston rod in any position. A screw is also provided which can be clamped to the piston rod of the cylinder so as to move the links by hand if there is a want of steam.

Relief valves are fitted at the end of each cylinder with gear to use them as starting valves. The connecting rods are forked at the crossheads and are fitted with strap ends. The crosshead journals are 10⅛ inches in diameter, and 10½ inches long, and the crank-pins are of steel 15½ inches in diameter and 20 inches length of journals. The crankshafts are built up in two lengths, and are made interchangeable; the main journals

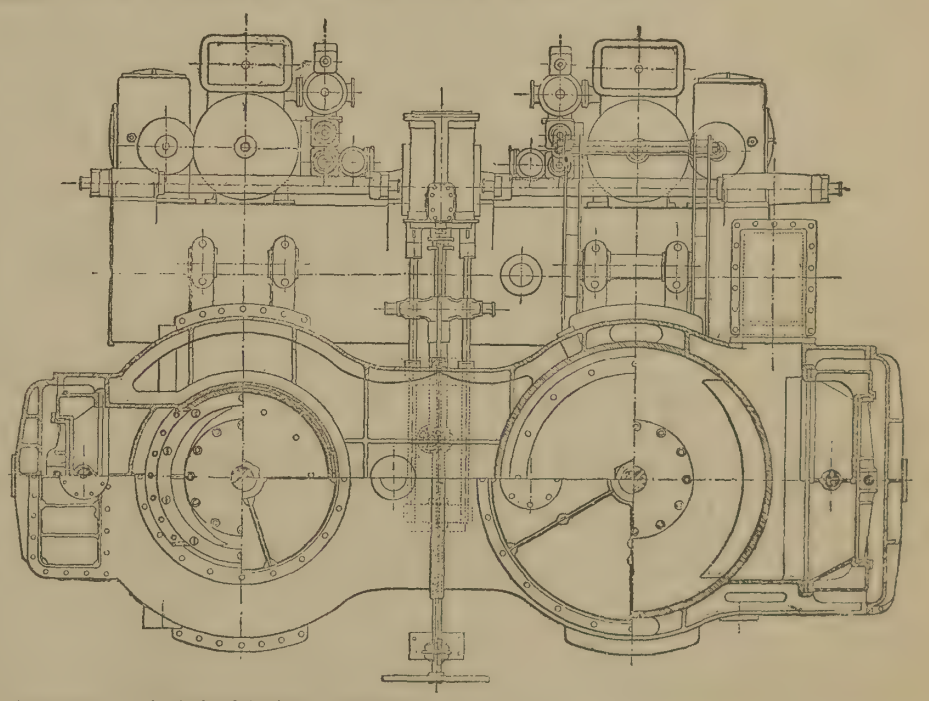


Photo-engraved by Smith & Shelmire, Philadelphia.

are 15½ in. in diameter and 30 inches long, except the forward journal, which is 24 in. long. The cranks are counterbalanced.

The bedplate is made in two parts and is bolted up to the condenser. This latter is in two pieces and contains 1492 tubes, ⅝ in. in diameter and 14 ft. long, the surface exposed being thus 4786 square feet. The water from one circulating pump passes through them three times and from the other twice. The pumps are worked from the main crossheads through wrought-iron levers as shown. Each air and circulating pump is cast separately and bolted to the condenser. A feed and a bilge pump are bolted to each air pump. The latter are 26 in in diameter, the circulating pumps are 18 in. in diameter, and the feed and bilge pumps are each 6 in. The stroke of all is 26 in.

* We have photo-engraved, from *Engineering*, the illustrations referred to. EDS. REVIEW.

A vertical turning engine is bolted to the side of the condenser and gears into a wormwheel fastened to the intermediate shaft coupling between the two cylinders. The propeller shaft is 15½ in. diameter, and is sheathed in the stern pipe. The propeller is four-bladed, with the blades cast separately and bolted to the bars; the diameter is 17 ft. and the pitch 24 ft.

The boilers are double-ended, three in number, and fired fore and aft. The diameter of each is 12 ft. 3 in. and the length 17 ft. There are three furnaces in each end 2 ft. 10 in. in diameter, with grate bars 5 ft. 4 in. long. There are 316 tubes 3 in. in diameter and 7 ft. long in each boiler.

The indicator diagrams [referred to by *Engineering*, and of which we cannot here annex copies] were taken from the engines of the Ohio during her second run, and under the following conditions:

Pressure of steam in boilers	60 ℔.
" " receiver	1·5 "
Vacuum in condenser	25·5 in.
Revolutions of engines per minute	60
Temperature of water in hot well	130°
Steam cut-off at 19 in. in the high pressure cylinder	
Indicated horse power in high-pressure cylinder	1237·44
Indicated horse power in low-pressure cylinder	740·1
Total I. H. P.	1977·54

The running of the Ohio during the voyage from Queenstown to Breakwater, when the above mentioned diagrams were taken, was as follows:

Date.	Knots Run by Screw.	Knots Run by Observation.	Running Time.	
1873.			hours min.	
Oct. 17	246.8	226.0	18 59	
" 18	323.8	280.7	24 23	
" 19	338.5	322.0	24 15	
" 20	335.7	294.0	24 23	
" 21	331.0	No obser.	24 0	15 min. detention.
" 22	341.5	No obser.	24 24	
" 23	336.7	946 in 3 days	23 43	18 min. detention.
" 24	339.5	333.7	24 22	
" 25	343.2	321.0	24 21	
" 26	142.0	140.0	10 30	
	3075.7	2863.4	9 days, 7 hrs. 20 min.	

The slip of the screw amounted to 212.3 knots, or 6.8 per cent., while the average speed was 12.8 knots. The weather was calm.

That the performance of the engines we have described has been most satisfactory is proved by the great regularity of the passages made by the vessels to which they are fitted, while their workmanship and general finish well deserve praise.

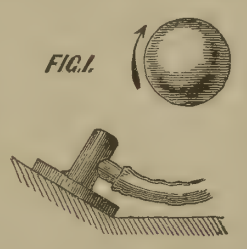
[*Engineering*, xxi, 64.]

A BALL SUSTAINED BY AN INCLINED CURRENT OF AIR.

This curious phenomenon which is shown by the Westinghouse Air Brake Company, in the Exhibition, has attracted considerable attention, and was mentioned by several members at one of the regular meetings of the *Technical Society* (Technische Gesellschaft) *of Philadelphia*. At the following meeting Mr. H. Bilgram suggested an explanation, which, together with the most interesting points of the discussion following the discourse, are herewith offered to the public notice.

THE PHENOMENON.—In exhibiting the Westinghouse Air Brake, Machinery Hall, Column D 68, a receiver filled with compressed air, at about seventy pounds pressure to the square inch, is required. When the brake is not shown in operation the air of the receiver, being continually supplied by an air pump, is allowed to escape through a nozzle of about ⅛″ bore, set to a vertical inclination of about 30°. Over this jet of air is placed a ball (see fig. 1), which remains afloat in the air without any visible means of suspension. There are five balls; a solid glass ball of 1½″ diameter, two solid wooden balls of 3″ and 3¾″ diameter, and two hollow rubber balls of 3″ and 5″ diameter, each of which, when placed in the jet, will show this phenomenon. Even more curious it appears when two balls are suspended simultaneously; the current of air, after leaving the small glass ball, being sufficiently strong to give support to the largest of the rubber balls. The impression this experiment creates is very striking indeed. As a rule, the suspended ball rotates very rapidly in the direction shown by the arrow, but sometimes it remains stationary, owing to the fact of the centre of gravity not coinciding with the geometrical centre; for the same ball, once made to rotate by an external force, will continue the rotation with increased speed. The vertical inclination of the jet may be changed to about 45° before the ball loses its state of suspension and drops off.

FIG. 1.



A similar phenomenon, a ball dancing on top of the water-jet of a fountain, is often seen, and will likewise remain sustained if the jet is more or less inclined.

THE EXPLANATION.—The investigation of the cause of this phenomenon was commenced with an examination of the course the air current takes in striking the ball. This investigation revealed the fact that the current *a b* (Fig. 2), instead of leaving the ball in the line *b c*, as might be expected, follows the curvature of the ball along the line *b d*, and at length leaves the ball in the line *d e*. A light ball, when placed in the jet, is struck nearly centrally (see Fig. 3), the current envelops the whole ball and unites again, leaving the ball in the line *d e*, appearing as though the current was passing through the ball. It can, however, easily be found that the upper branch of the current is stronger than the lower one.

FIG. 2.

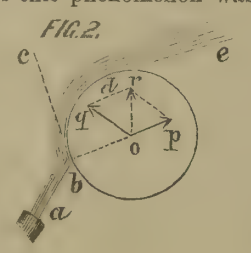
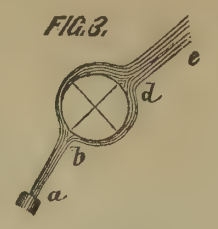
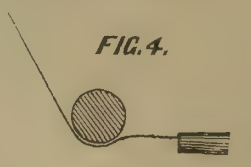


FIG. 3.



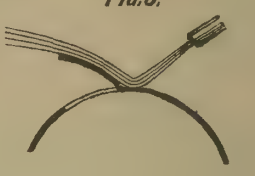
By a series of subsequent experiments, it was found that any current of air striking a convex surface, has the tendency to follow that surface. One of these experiments is as follows:—Attach to one end of a small tube, about ⅛″ to ¼″ diameter, and 4″ to 6″ long (which may be made by rolling up a piece of writing paper), a piece of thread or yarn, about 4″ to 5″ long. Blow through the other end of this tube and direct the current against an object with a convex surface. The thread, following the current, will indicate a deflection as shown by Fig. 4.

FIG. 4.



After demonstrating this fact, the next step was to find its cause. It is well known that any current tends to carry along with it the surrounding particles of air; hence, the supposed current *b c* (Fig. 2), being freely supplied with air from the left side only, will create a rarefication of air in the angle *c b d*. It is thus exposed to a one-sided pressure, and will therefore be deflected, as mentioned, and follow the curvature of the surface until it meets a counter current sufficiently strong to prevent a further rarefication. If this view can be substantiated, it is plain that two external forces are acting upon the ball. One, the impact of the air-current at *b*, transmitted at right-angles to the surface, acts radially, and can be represented by the line *o p*. The other force, *o q*, is occasioned by the surplus pressure of the atmosphere on the lower side of the ball, over that of the rarefied zone under the curved current, and combined with *o p* it forms the vertical resultant *o r*, by which the weight of the ball is sustained.

FIG. 5.

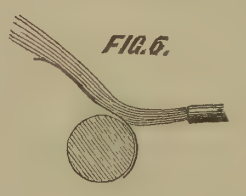


The rarefication of air under the deflecting current can be proved by the following experiments:—

Cut a small hole, say ½″ square, in a card board, fasten over this hole a cover of the same material, by means of a strip of thin paper and mucilage, to form a valve, and bend both the card and the valve into a cylindrical form. If now a current of air is directed against the card, as shown in Fig. 5, the valve will open wide, showing the pressure under it to be greater than that above it.

Or, take a strip of ordinary paper, about 1″ to 2″ wide, lay it over a cylindrical surface and blow against it in a nearly tangential direction. The end of the strip will then rise as shown in Fig. 6.

FIG. 6.



Quite a number of other experiments might be mentioned, showing the same facts.

The rotation of the ball is produced by the friction of the air-current passing over the ball, and is therefore a secondary result.

The phenomenon of deflection of a current when striking a convex surface can be brought to bear on geographical and meteorological facts. The Gulf Stream follows the curved shore of the United States, for the identical reason that the ærial current follows the shape of a cylinder or a globe, and takes a course which otherwise it would not take. When a current of the higher strata of the atmosphere strikes the peak of a mountain it will be deflected, follow the sides of the mountain, and will sweep the valley.

THE FRANKLIN INSTITUTE CLASS IN PHONOGRAPHY.

It affords us pleasure to call attention to the fact that the Franklin Institute has made arrangements for a class in Phonography, or phonetic short-hand, under the direction of the Actuary, Mr. Holman. The Institute drawing schools have proved deservedly popular and will be continued. In reference to phonography, we wish to add our testimony to its extreme simplicity and great utility. We have been a phonographer about fifteen years. During that period, the aid given us by phonography (which is a perfect and consistent system of rapid writing, as distinguished from the present slow and defective general mode), has been important, and we here gratefully acknowledge it. So far from being a crazy hobby, to be ridden by long-haired fanatics, it is a useful system, abridging time and lessening labor, and worthy the very little time it takes to thoroughly acquire it, in the mere matter of facility in making notes, memoranda, excerpts, &c. Turning to the advertisement of the class mentioned, on our first cover page, the unskilled reader will note four characters, which represent four words, or twenty-three of our ordinary letters: "WHATSOEVER THINGS ARE TRUE."

We very strongly advise all of our readers who have not the good fortune to possess this time and labor-saving accomplishment, to devote to its acquirement the ten or fifteen hours that are needed for its mastery. G.

TO OUR CONTEMPORARIES.

We have been in receipt of so many, and repeated, kind notices from our co-laborers in reputable journalism, that a public acknowledgment of their courtesy is due, and is hereby gratefully tendered. Perhaps the most valued expression of fraternal appreciation, is the reproduction, with due credit, of our articles and illustrations. In this latter connection we beg to say that we shall be very happy to loan or sell electrotypes to any of our exchanges who will afford us equal facilities.

Among so many notices, very naturally there is quite a number that escapes our view. The reception of a *marked copy* of any publication referring editorially to our journal, would be especially and highlyappreciated by

THE EDITORS OF THE POLYECHNIC REVIEW.

THE HARRIS CORLISS ENGINE.—We have had prepared, by MR. JOSHUA ROE, a very exhaustive and practical illustrated article on this celebrated engine; and hope to have the pleasure of presenting it to our readers at a very early date.

A NEW "SHORT-CUT" METHOD FOR DESCRIBING GEAR TEETH.

The rattling so common to cast gearing is due to two causes; first, the actual errors in the shape of the teeth, and second, inaccuracy of construction. The latter, being a matter of workmanship and skill alone, will not be considered here; but the former is due, to so great an extent, to a want of familiarity with proper method for laying out teeth, or the tendency, when familiar, to avoid the trouble of correct delineation by guessing at the curves, that the following "short cut" plan, by means of a new *Template Odontograph*, has been devised, by Professor S. W. Robinson of the School of Mechanical Engineering of the Illinois Industrial University.

This instrument possesses the novelty of being, in itself, a ready-made and universal scribe templet, equally serviceable to the draughtsman and pattern maker for laying out, with great accuracy, all kinds of gearing, and without aid from drawing instruments or elaborate books on the theory of gearing.

The instrument is founded upon theory, as elaborately demonstrated in an article which appeared in *Van Nostrand's Engineering Magazine* for July, '76; and, though a considerable portion of higher analysis is required to prove its applicability, the practice is reduced to such a simple operation that the most untutored cannot fail to apply it correctly.

The instrument is shown, full size, in Fig. 1. It consists of a piece of flat brass about a sixteenth of an inch thick, finished and graduated on both sides alike. The two curved edges are the important elements, and each is formed from one and the same logarithmic spiral whose "obliquity" is 2. The applicability of this curve depends upon two properties of it; first, that the involute of the logarithmic spiral is another like spiral with poles in common; and second, that the obliquity, or angle between a normal and radius rector, is constant; the latter being possessed by this curve alone. By the first property it is known that a line lying tangent to the curve C F H will be normal, or perpendicular to the curve C D B; so that when the line D E F is a tangent to the pitch line, the curve A D B will be in very close osculation with the epicycloid. By the second property all sectors of the spiral, with given angle at the pole, are similar figures, which admits of the same degree of osculation with all similar epicycloids, whether great or small, and nearly the same for epicycloids in general, thus extending the application of instrument to epicycloidal gearing in general.

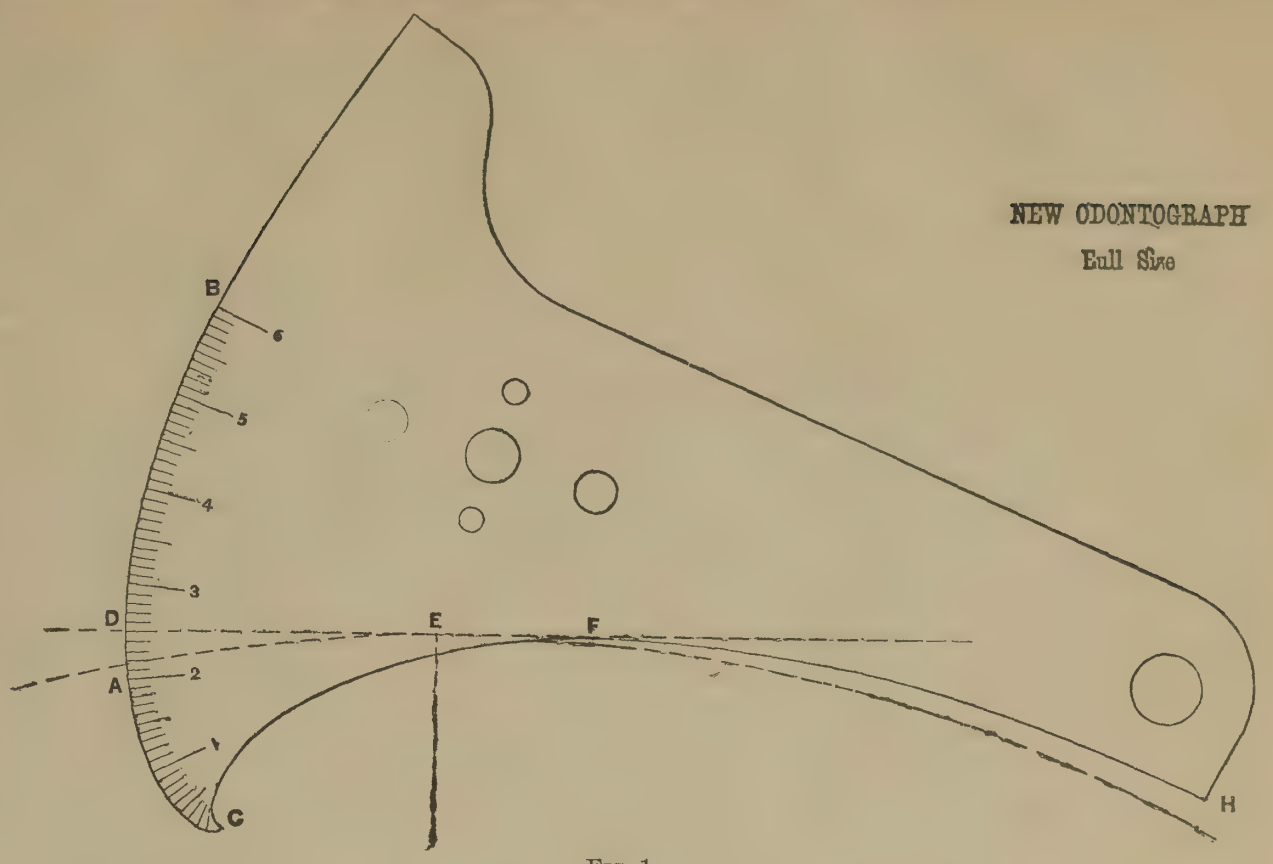


FIG. 1.

These properties are found sufficient to admit of the instrument being placed, in the same manner, on any epicycloid, and in close contact with it, by aid of a number obtained from the pitch circle, the generating circle, and the number of teeth in the wheel for which the teeth are sought. These numbers, which have been styled index numbers, because they serve as an index to the scale of the odontograph, are computed with care from formulas, deduced and given in the magazine article above mentioned. These numbers, divided by the pitch, were also given in tabular form in the magazine, but have since been put in much more suitable shape for practice in No. 24 of *Van Nostrand's Science Series*, which contains the Odontograph article, and also an article from the magazine on the forms of the teeth of wheels and from which are taken, through the kindness of D. Van Nostrand, the first two cuts illustrating this description. The tables in the magazine article apply for radical flanks only, but those in No. 24 *Science Series* are more complete, and extend to all gearing, such as required for "sets" or interchangeable gears; and for teeth with flanks braced or strengthened to any desired extent. These tables are also given below, somewhat abridged, though sufficient for usual practice.

Many of our readers will doubtless desire to learn something of the connection of this odontograph with the theory of tooth curves, without the trouble of following the line of mathematical reasoning given as above mentioned. To this end the following description of the steps is given. But before proceeding to this, it is desirable to point out just what are the conditions of the tooth-curves the instrument is to give.

In the article on forms of teeth, above mentioned, it is shown that any pair of pitch lines, circular or non-circular, may have correct working teeth described for them by taking any kind of curve whatever for a describing curve, and rolling it on the outside of one, and the inside of the other pitch line in the same direction, for generating a face and flank, which will work correctly. This operation is exhibited in Fig. 2.

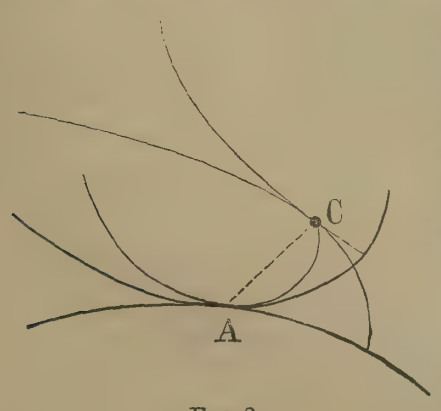


FIG. 2.

These tooth-curves will each be wholly on one side of their respective pitch lines, one within and the other without. The next pair of faces and flanks may be described with the same, or any other describing curve. To describe the other halves of the teeth, or the curves for the other sides of the pitch lines into which these curves are to be extended for completing the teeth, describing curves are to be similarly rolled upon the other sides of the pitch lines.

These few words really comprehend the whole general theory of gearing, which, however, is much more elaborately set forth and illustrated in the *Science Series* above mentioned. Epicycloidal gearing is therefore only a special case in which the pitch lines and describing curves are circles. Therefore, for this particular form roll any circle on the outside of one, and inside of the other pitch circles for a face and flank, and for the flank and face of same teeth, roll this, or any other circle, inside and outside respectively. We thus obtain one side entire of a tooth of each wheel, and they may be used as patterns for the rest. When the diameters of these rolling circles are equal to the radii of the pitch circles within which they roll respectively, the hypocycloids will be simply diameters of the pitch circles, and hence the tooth flanks radial. Smaller rolling circles give flaring flanks. If a given rolling circle be used for a number of different pitch circles, inside and outside, the wheels will work correctly together in any interchangeable manner, as in "sets."

Involute teeth also form a special case of the general theory in which the describing curves are logarithmic spirals rolled on the *pitch* lines. The same curves are, however, more conveniently described by unwinding a thread from a cylinder of certain size with pencil attached. The odontograph curve will represent all these curves, as far as required for the teeth of wheels, and with a wonderful degree of precision. This known, it only remains to discover a mode of setting the instrument, and of procuring the tabular values.

It is first necessary to decide on a particular logarithmic spiral, because it may have an indefinite number of obliquities. If circle arcs will give a reasonable approximation to form of tooth, as contended by some prominent gear makers, then a logarithmic spiral, very carelessly chosen even, will do far better, for it is a curve, some portion of which very much resembles such initial part of an epicycloid as required for a tooth. But it is evident that some form is best, and this is found, by a method, partly graphical and partly analytical, to be one whose obliquity is 2, and is the one adopted for the instrument with great confidence as to close coincidences.

An equation of the odontograph curve was next obtained, which was combined with the equations of the epicycloid, the hypocycloid, and the involute. The combinations with the first two gave expressions for the index numbers in terms of the diameter of the generating circle, and of the radius and number of teeth of the wheel for which the teeth are sought. These are given in the table below, and apply for all kinds of epicycloidal gearing. The combination with the involute gave the index numbers for involute gearing. From the fact that these are expressed in terms of number of teeth only, the table is very simple.

For the rack and pinion the faces of the teeth of the rack are cycloidal, and the index numbers for this are given by themselves. The faces of the pinion are involutes, and hence the same table applies as for involute teeth.

The formulas which give these tabular values require that the odontograph be set to a tangent, D E, to the pitch line, E being taken for the middle of a tooth. Also the index number must fall on tangent line, D E, the index number being 2·5 for the setting shown in Fig. 1. The point of tangency, E, must be the middle of a tooth. The dotted circle, A E H is, the pitch line. When the instrument is once set, the pencil, pen, or scribe, is to trace the curve, A D B, for the face of a tooth.

The instrument has countersunk holes shown in the cut, so that it can be mounted upon a radius rod, by wood screws, and swung around a centre pin to the wheel to lay out all the teeth, in the same manner as with any other templet. The instrument can then be reversed to position for the opposite face of tooth, and treated likewise.

When the generating circle chosen has its diameter equal to the radius of the opposite pitch circle, the flanks of the teeth will be radial, and very conveniently drawn. But when the relation is otherwise, the flank will be curved, and the second part of the table is given for setting for them. The formulas, however, require that the instrument be set by aid of a different line than D E, for the flanks. The tangent must be drawn to the pitch line from the side of the tooth instead of middle, as from A in Fig. 1. Also, the instrument should have its back toward instead of from the centre of wheel. Therefore, for the flank, the end, H, should be wheeled around nearly 180°,

and set to a tangent drawn from A. A similar tangent, and setting, is required for the opposite flank.

Fig. 3.

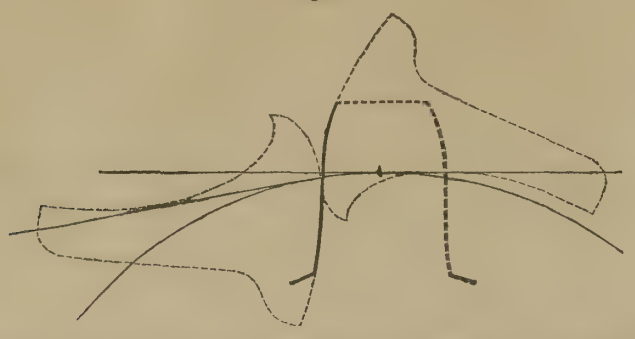


Fig 3 shows at a glance how the odontograph is placed for drawing the faces and flanks.

In the case of involute teeth the settings are made in the same way as for above case of radial flanks, except the tangent, D E, must be drawn from the *base circle* of the involute instead of the pitch line. But the tooth-thicknesses should still be laid off on the pitch line. For all these cases the radius rod may be brought into requisition, whether the drawing is to be done on the drawing board or wooden pattern.

Table of values of index number, divided by pitch in inches, for use in setting the Odontograph.

Radius of wheel sought Divided by *Diameter* of generating circle.	Number of teeth in wheel sought. 8	16	24	40	56	80	112
	For Faces.						
$\frac{1}{12}$ =.083	.321	.458	.555				
$\frac{1}{4}$ =.250	.311	.438	.540	.692	.853	.982	1.303
$\frac{1}{2}$ =.500	.283	.406	.504	.654	.786	.930	1.132
$\frac{2}{3}$ =.667	.266	.382	.479	.627	.748	.895	1.089
1	.230	.338	.435	.577	.693	.832	1.007
$\frac{3}{2}$ =1.50	.193	.294	.381	.511	.618	.727	.896
2	.174	.260	.336	.458	.560	.679	.795
4				.328	.409	.491	.600
12					.243	.286	.417
	For Flanks.						
1.5.	.775	1.177	1.540	1.958	2.477	2.918	3.390
2	.440	.632	.805	1.094	1.330	1.588	1.894
3			.465	.650	.818	1.025	1.289
4			.276	.410	.556	.714	.908
6			.200	.324	.418	.522	.633
12					.308	.369	.430
	For both Rack and Pinion faces, use number of teeth in *Pinion*.						
Rack.....	.338	.513	.657	.884	1.071	1.304	1.573
Pinion.....	.323	.443	.551	.718	.847	.990	1.122

N. B.—For the *faces*, the pitch circle tangent for setting the instrument should be drawn from the middle of tooth, and for flanks it should be drawn from the side of tooth as explained. For involute gears use the line of figures headed *Pinion*—the one line being sufficient—using for each gear its number of teeth. For the rack and pinion, the tabular values are for radial flanks for each. Should other forms of flank be desired for the pinion, they may be laid out for it as for any other gear, but in this case the rack must have its tabular number for face formed by taking for "number of teeth" the number in pinion divided by *radius* of pinion and multiplied by *diameter* of generating circle, which rolls in pinion.

EXAMPLES.—To show more clearly how the table and instrument are used in practice, the following examples are given. Take the same given wheels and pitch for all, viz: wheel 56 and pinion 16 teeth, pitch 2 inches.

1st. Epicycloidal teeth with radial flanks. For this we only need the first part of the table, because the instrument is only needed for the faces. The first column ratiod is equal to 56 divided by 16, or $3\frac{1}{2}$, which is the same as radius of wheel divided by diameter of rolling circle for face of that wheel. In first column of table we find $3\frac{1}{2}$ is between "2" and "4." Under the number of teeth, "56" opposite "2" and "4" we find .560 and .409 respectively. Interpolating for $3\frac{1}{2}$ gives .447, and this multiplied by the pitch gives $.447 \times 2 = .894$, the index number for wheel teeth. The tangent may then be drawn from the middle of a tooth; the half thickness laid off; the odontograph set; the face curve drawn; and the flank struck in, which finishes the whole side of one tooth.

For the pinion the first column ratio is .286, which falls near ".250." Under "16" we find, by interpolating, .433; and multiplying by the pitch gives .866 for index number.

Next, suppose flanks not radial, but generating circles half as large as for radial flanks, or one fourth the size of the wheels. For the faces, first column ratios will be $\frac{56}{8} = 7$, and $\frac{16}{28} = .572$. The index numbers are obtained as before. For the flanks, the first column ratios will be $\frac{56}{28}$ and $\frac{16}{8}$, or 2 simply, and hence the tabular values are 1.330 and .632, and index numbers 2.660 and 1.264 respectively. These are to be used to set the odontograph on the tangents drawn to the pitch line at the sides of tooth. The use of the tables and instrument will be readily understood without multiplying examples farther.

These instruments are manufactured at the Laboratory of the School of Mechanical Engineering of the Illinois Industrial University, Champaign Ill.;

J. C.

THE SCHUYLKILL WATER DURING LAST WINTER.

BY WILLIAM TRAUTWINE.

I.

Throughout the winter of 1875-6 many persons living in the north-western part of the city, and in West Philadelphia, observed a peculiar appearance in their water supply. From cold water spiggots it frequently issued of a light milky tint, while the hot water was often almost chalky in appearance. This was particularly noticeable when the stop-cock was suddenly half-closed, so as to restrict the outflow after it had been fully opened. The milky appearance was more decided in the bath-room than in the kitchen. A basin full of the hot water often appeared too repulsive to wash in, and a tumblerful of the cold water was generally allowed to "settle" before drinking. This "settling" was not to the bottom, but to the top; and thence into the atmosphere. It was simply the escape of innumerable minute air bubbles intimately entangled in the water. A glass-full held toward a bright light demonstrated this. So milky and fouled was the water to all appearances, that this simple explanation might be doubted. But it was noticed that nothing solid or liquid subsided, and that the clouds of particles which appeared solid, rose to the surface, and were heard hissing as they escaped, by holding the ear close to the water.

It must be remembered by those who have wondered over their chalky-looking water-supply, that the same Schuylkill water, furnished to other parts of the city, lacked the phenomenon peculiar to theirs.

Fears were expressed by some that the gas bubbles, supposed by them to be carbonic acid, would affect the lead pipes, forming carbonate of lead, which, taken into the system even in minute quantities, in time produces poisoning. Water containing carbonic acid, but otherwise pure, cannot safely be supplied through lead pipes. Most drinking waters, however, like the Schuylkill, contain a small proportion of sulphate of lime, and this, decomposed by the lead, coats its surface imperviously with a glaze of insoluble sulphate of lead, which prevents further action. The water in question yields no traces of lead on examination. Iron is present to the extent of perhaps one-fifth of a grain to the gallon, more or less; but this is immaterial.

Various plumbers suggested that the milkiness was owing to a re-action between something unknown but supposed to be present in the water, and the iron of the range boilers; while others inferred that "lime" was present in quantities sufficient to give the water "a color."

A correspondent of the *Public Ledger* stated some months since that the peculiar appearance of the water was attributable to the presence of carbonate of lime and carbonic acid; meaning, it is presumed, that the water held an unusual quantity of bicarbonate of lime in solution,—or, as would have been expressed formerly—that the water was impregnated with carbonic acid gas, which held carbonate of lime in solution. The cloudiness, therefore, being caused by the liberation of myriad bubbles of carbonic acid gas, and the consequent precipitation or subsidence of a cloud of carbonate of lime. But, as it was, nothing subsided. There was not an appreciable quantity of any carbonate in the water. It did not effervesce with acids, when hot, or cold, or when concentrated by partial evaporation. As it issued from the spiggots it was neither acid nor alkaline. Bottled full of the bubbles, it failed to give the faintest acid reaction with any or all of the most delicate tests for free carbonic acid. The bubbles were collected until a sufficient amount of the gas was secured for deliberate examination. It neither extinguished a lighted taper, clouded lime-water, affected litmus solution, nor was absorbed by potash solution, and manifestly was not carbonic acid. It was non-combustible and inodorous, and therefore neither hydrogen, carbonic oxide, carburetted hydrogen nor phosphuretted hydrogen. A stick burned freely in it; consequently it was not nitrogen. Neither was it a mixture of air with an appreciable quantity of any of these gases.

Notwithstanding the striking appearance caused by the superaeration of the water, the proportion of air liberated from it on exposure was quite small.

Cold water under pressure, or when agitated, dissolves a considerable quantity of air, which is liberated by heating. The greater opacity of the hot water was caused by the liberation of air dissolved in the cold water when heated in the range boiler. As the air, insoluble in the hot water, could not escape until the stop-cock was opened, the water as it flowed out still contained the air particles distributed through its bulk. The pressure which confined them being removed, these soon rose to the surface and escaped. As the supply pipes usually ascend directly from the kitchen faucets to the bath-room, the greater part of the liberated air naturally rose and accumulated in the pipes. This will explain why the milkiness was most noticeable in the bath-room. Any undissolved air in the street pipes, or air liberated from the water in them, would accumulate in the most elevated districts; and the phenomenon was most decided in the higher parts of north-western and West Philadelphia.

[*To be continued.*]

TO STOVE MANUFACTURERS.

Mr. Alban E. Jacobi, Special Royal Swedish Commissioner, and a member of the firm "J. & C. G. Bollinder's M. V. A. B.," Stockholm, has requested us to obtain for him a complete set of illustrated catalogues of American stoves. Those of our American manufacturers who have no objections would confer a favor (that may be reciprocated in a practical manner) by mailing their catalogues to the address indicated, or to the editors of this journal, for Mr. Jacobi.

ADJUSTABLE SCREW CUTTING DIES.—Mr. Joshua Rose has prepared for us an illustrated article on the above-named topic, and which will appear shortly in our columns.

THE CORLISS TYPE OF ENGINES.—We have in preparation by Mr. J. Haug, an exhaustive illustrated article on the Corliss Engine and its congeners.

Fig. 1.

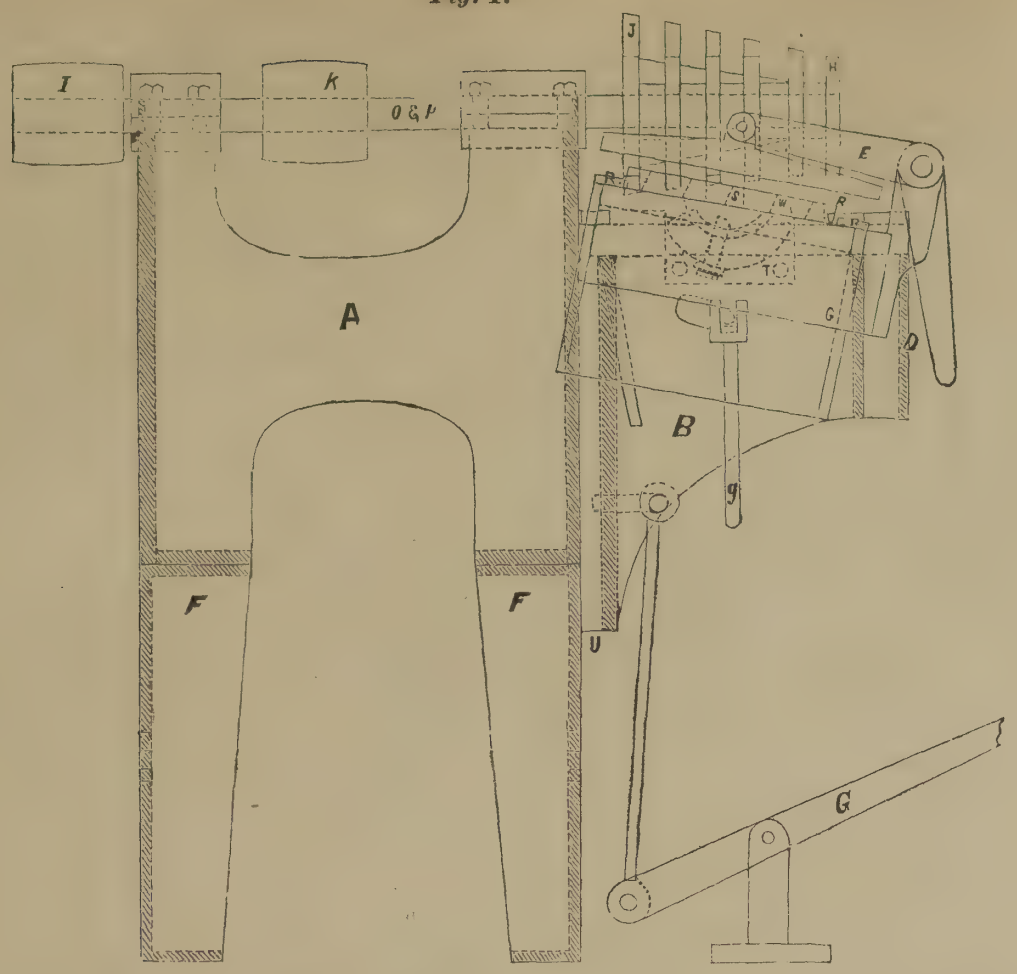


Fig. 2.

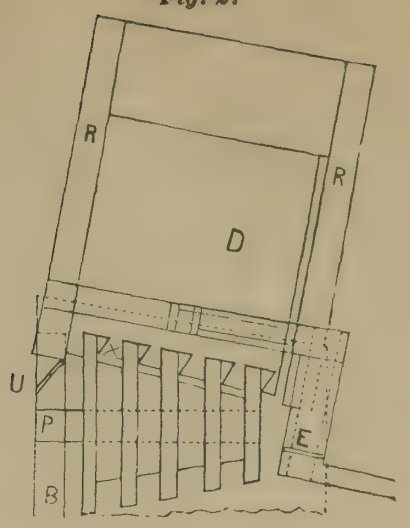
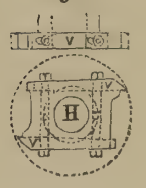


Fig. 3



THE GOULD DOVETAIL MACHINE.

(Machinery Hall, Column A—33.)

This machine is the invention of R. J. Gould, Newark, N. J., makes the regular dovetail joint by a quick operation, and can make them on work of any width.

In Fig. 1, A represents the main frame. B is a table that slides perpendicularly on the main frame; it is raised and lowered by a treadle, G, and carries the table, C, and the table, D, Fig. 2. C is a tipping table on which the tenons are cut; it rests in a circular bearing in the part T, having a center at S, which center is on the line of the top of table, C. By this means the table, C, is tipped on either side at the desired angle, without moving it laterally. The lever, *g*, is a cam which holds the table, C, in the position required to make the two cuts for the tenons. The shaft, O, is driven from the counter shaft by a cross belt. The cutters, H, are bolted on the head with cutting edges parallel with the shaft, O, and are all of the same diameter.

To cut the tenons, the work, W, is put on the table, C, with one edge against the left gauge, R, and secured in place by the hold-down, G. The table B is raised, so that the work will be cut through, and is then let down again. The table C is then reversed and raised and lowered, as before. One end will then be finished. To cut the other end, the piece is turned around with the same side on the table and the same edge against the right hand gauge, R; the machine is operated as before, and the piece is then finished. The mortise part is cut by the bevel cutters, J, which are on the shaft, P, driven by the pulley, K, with a straight belt; the cutters are of *different* diameters, and have cutting edges at an angle to the shaft. The table D, Fig 2, is attached permanently to the sliding table, B, with the gauges, R R, at a right angle to the cutting line.

To cut the mortises the work is placed on table D, against gauge R, on left side; is cut through and turned over to the right hand gauge, R, and cut again. The other end is turned to the cutters, placing the same edge to the left gauge, R, and the same side down, is cut and turned over; the piece is then finished. The tenons and mortises are cut at the same time.

Fig. 3 represents the head, which is similar to those in moulding machines; the steel cutters are made taper, and are bolted through oblong holes, to allow the wear to be taken up and to keep the same diameter. The advantage of using cutters at a high speed is evident. Between and at the face of the cutters are hard wood supports, which are cut out by the machine and prevent the work breaking out, when cut.

On the tables C and D are indexed gauges to regulate the depth of the cut.

The mortise work can be cut several at a time if fastened together.

By having movable index gauges on the sides, the machine can cut two or more times the width of the cutters.

These machines are made to order, so that the kinds of work specially required can be done to the best advantage.

The owner of these patents wishes to dispose of them to some manufacturer of wood-working machinery who has facilities for selling them. See advertisement, front page of cover.

CONCERNING SPONTANEOUS COMBUSTION.

VI.

The spontaneous combustion of coal is a well-established fact. The phenomenon is confined, of course, exclusively to the class of coals that for want of a better name are called bituminous. Such spontaneous firing occasionally occurs in the heaps of coal stored in ships, at the gas-works, and in other situations. The cause of this process is, however, the subject of very general misapprehension. The opinion is almost universally entertained that the spontaneous ignition of coal is occasioned by the decomposition of iron pyrites, which is present in greater or less quantity in almost every variety of coal, and in the shale which accompanies it. Upon exposure to the combined effects of air and moisture, the pyrites oxidizes with eagerness, and is capable of developing a large amount of heat, and when the disposition of the mass is such that the heat given out during this process cannot be dissipated, ignition may, without question, eventually occur. The atmospheric oxidation of pyrites is, however, a comparatively slow process, and though, doubtless, the tendency of a coal to fire spontaneously is materially facilitated by the presence of pyrites, as will shortly appear, the recent investigations of Richters and others* have shown very conclusively that this cause is not sufficient to account for the majority of well-substantiated instances of spontaneous ignition of coal in various situations. Richters' investigations have conclusively shown, that the coals most liable to spontaneous ignition are *not* those containing the largest percentage of iron pyrites, but that this property is principally due to the atmospheric oxidation of the organic substance of the coal. The phenomenon of spontaneous ignition is therefore, in its origin, identical with the so-called weather-waste of coal, a species of deterioration from exposure to the atmosphere to which many varieties of coal are notably subject. This deterioration, as Varrentrapp has shown,† is in some cases so notable as to amount to a total loss in weight of a specimen, of 33·08 per cent, while its deterioration in quality for purposes of fuel or gas-making reached a still higher figure. This deterioration is facilitated in the coals containing pyrites, by the presence of moisture; but in coals free from sulphurets, weather-waste appears to occur without the presence of moisture, and this species of oxidation, with such coals, we have it on good authority, may even take place with more energy when they are dry than when wet. This assertion, however, we believe, is open to considerable doubt. The process is assisted by increase of temperature and by the condition of the coal, being most rapid when the latter is in the condition of dust or slack.

From all the facts at hand bearing upon the subject it may be safely asserted that the tendency in coals to spontaneous ignition cannot be safely estimated, either from the amount of sulphur or the amount of volatile matter they contain, as the following examples will prove. Many of the anthracite and semi-bituminous coals contain a large percentage of sulphuret, but they nevertheless never ignite spontaneously; while on the other hand some of the most pronounced self-inflammable coal contains *little or no* sulphur. A well-informed journal‡ gives us, upon this point, the case of several thousand tons of albertite (a rich, gas-producing mineral, quite *free* from sulphur), which being piled on a dock in Boston, oxidized so rapidly that it heated and fused, running together round the edges of the pile, and finally, we are told, even ignited. On the other hand, cannel coal, which contains an abundance of volatile matter, and often very little sulphur, never ignites spontaneously. The same journal gives the following excellent summary of the subject, which so concisely and correctly expresses the nature and causation of the phenomenon we are discussing, that we give it *verbatim*.

"The spontaneous ignition of coal is, doubtless, greatly facilitated by, though not altogether due to, the presence of iron pyrites; for the oxidation of the iron pyrites is attended with a considerable development of heat, and by swelling, it splits up the coal, and renders it more pervious to oxygen. The real cause of spontaneous

* See Percy's Metallurgy, ed. of 1875.

† Jour. Frank. Inst. lxiii, 32.

‡ Eng. and Min. Jour. xx. 329, *et seq.*

ignition is, doubtless, the oxidation of the organic substance of the coal. It is, in fact, a very energetic case of 'weather-waste,' and the precautions to take in each case are the same.

The gravity of this subject will perhaps be better appreciated by the introduction of a few illustrations showing the frequency of disasters from the causes here alluded to. We may particularize here by referring to the recent destruction at sea, by fire, of the fine ship Centaur of Boston, a disaster which at the time (September, 1874) was the theme of much comment on the part of the public press. Upon this subject, one of the influential journals comments as follows: "It is somewhat remarkable that the owners of the Centaur should have lost by fire another of their ships in the Pacific Ocean almost at the same time and within a short distance of each other. * * * Both ships were laden with steamboat coal and were bound on the same voyage, and the origin of the fire in both cases was the spontaneous combustion of the coal. The destruction of four Boston ships—the Sierra Nevada, Pocahontas, Mogul and Centaur—within so short a time, and all from spontaneous combustion, has created no little stir in the commercial community, as the frequency of the disasters from this cause has been quite unexampled. Besides these losses, the English ships Staffordshire and Workington, and bark Lady Heathcoate have also been on fire from the same cause. All of these vessels were carrying soft coal from England to ports in the Pacific. * * * In the case of the Workington, which was taken into Montevideo with cargo on fire and scuttled and sunk, a subsequent attempt to recover the property resulted in an explosion that tore away the deck of the vessel, and both ship and cargo were a total loss."

The destruction of the Pacific Mail Steamship Company's steamship Japan, is an event of such recent occurrence as to be fresh in the minds of all our readers; and the testimony elicited by the court of inquiry summoned at Hong Kong to investigate the cause of the disaster, leaves little room to doubt that it was the same as in the cases just alluded to. The first officer of the vessel (Mr. Hart) unequivocally asserts that "spontaneous combustion of the coal was the cause of the fire. To the best of my knowledge 600 tons of fresh coal were taken in at Yokahama (of which, incidentally remarked, 400 tons were native bituminous). During the hours of coaling it was raining heavily, so that the coal must have been wet when taken on board." The finding of the court was in accordance with the above statement, and the officers of the ship were exonerated from any responsibility in the calamity that cost a fine vessel and a large number of human lives.

The London *Engineer* of a recent date publishes a list of 196 disasters to sea-going vessels from fire in coal-bunkers, or in cargoes of bituminous coal, which occurred between the months of October, 1869, and December, 1875. All of these vessels were damaged and many were destroyed; and the same journal appends to the above statement a record from Lloyd's of 65 sailing vessels and 4 steamers loaded with coal that were reported missing between July 1, 1873, and February 1, 1876.

The burning of ships laden with cargoes of coal through the spontaneous combustion of their cargoes is a fact of such frequent occurrence as to have called for the appointment, some time ago, by the British Government, of a Royal Commission to inquire into the matter and suggest such remedial measures as the circumstances warranted. It has been affirmed that not less than 4 per cent. of all the coal-laden vessels that have left English ports, during the last five years, for destinations south of the equator, have suffered either total or partial loss by the spontaneous ignition of their cargoes. The importance of any investigation that will lesson this risk will therefore be apparent. This commission has just issued a report, which, while it agrees in every particular with what we have said of the cause of the phenomenon, presents some new and excellent suggestions as to the conditions of safety which are of much practical value. Upon this portion of the Report of the Commission, the following summary gleaned from the papers of the day, will present the conclusions arrived at.

Heretofore, in the inquiries made into particular disasters of this kind by local English authorities, better ventilation of the cargoes was recommended as a remedy. It was found, however, that these disasters sometimes happened in the best ventilated ships, and, in fact, it was finally demonstrated that the more thoroughly safety was sought in ventilation, the more frequent became the disasters. The report mentions that many ship captains have a traditional dislike to ventilating their ships, but in this they were overruled by the insurance agents, and finally the Liverpool underwriters recommended a special system of ventilation. It was stipulated for in charter parties and was, in fact, looked after as carefully in effecting insurances as the age and rating of a ship. The Royal Commission, after carefully examining the whole matter, say that certain descriptions of coal are intrinsically dangerous for shipment on long voyages, and that the breakage of coal in its transport from the mine to the ship, the shipment of pyritic coal in a wet condition, and "especially ventilation through the body of coal cargoes" conduce to spontaneous combustion even though the coal may not be unfit for conveyance on long voyages. They urge attention to these facts by both ship owners and underwriters, so that spontaneous combustion in coal cargoes may be less frequent, and that when coal is being carried on long voyages the temperature in various portions of the cargo be tested periodically and recorded in the log. They also suggest, as a precaution against explosion, that free and continuous egress to the open air, independently of the hatchway, be provided for the explosive gases by means of a system of surface ventilation effective in all kinds of weather. The Commission do not designate the particular kinds of coal which are liable to spontaneous combustion, but they suggest that the Royal Inspectors of Mines make inquiry into each case as reported, exporters being required to make a record of the different denominations of coal forming the cargo. This record will show what coal is and what is not dangerous, and in time cause the former to be avoided as a cargo for long voyages.

Another precautionary measure to insure the safety of coal-laden ships is to fill their holds and bunkers with carbonic acid gas, which by expelling the air would prevent the oxidation of either coal or sulphurets. The practicability of this system, however, remains yet to be determined, although it appears to be well worth a trial.

It might also be found serviceable as an additional safeguard, to introduce into such vessels an automatic electrical signal system, which would serve the useful purpose of indicating in the officers' quarters, by the striking of a bell, the fact of the unusual heating of any part of the cargo, and indicate the dangerous locality; thus rendering it possible, by the timely warning given, to conquer the danger before it has passed beyond control.

In the gas-works, the coal heaps are uniformly watched with vigilance. In some such establishments, long iron rods are placed upright in the coal heaps, which on being pulled out indicate by their warmth the precise situation of the fire. The obvious precautions to be taken to prevent accidents in such cases will be, to avoid the presence of water moisture by storing the coals dry and keeping them under cover, and wherever it is possible, to locate the heaps where they can be turned over readily as soon as the first indications of heating are manifested. W.

PROGRESS IN SCIENCE AND THE ARTS.

CENTENNIAL NOTES.

WATKINS' GAS ATTACHMENTS FOR STREET LANTERNS.

The accompanying engravings represent a useful attachment for street lanterns, which, under the name of "Watkins' Patent Portable Gas Attachment," is on exhibition in Machinery Hall, Section E, 69.

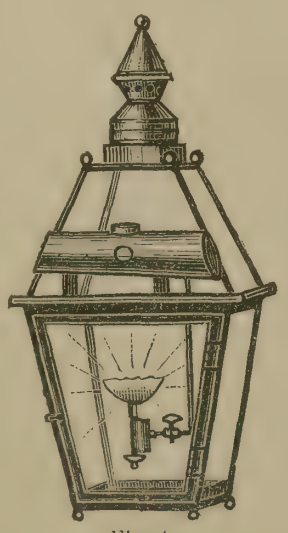


Fig. 1.

The purpose of this invention is to supply a cheap and excellent gas light for street lanterns, without employing the usual accessories of street mains and service-pipe. The attachment can be placed upon any form of street lantern in use, and the duration of the light, as will be seen hereafter, is automatically controlled to the number of hours that may be desired, from the time of lighting.

The device consists, as will be seen in the engraving, of a reservoir, placed outside of the lantern on the collar of the lantern frame. Connected with the reservoir, and leading inside of the lantern, is a pipe and valve, to which is attached a burner of peculiar pattern, called by the inventor the "Solar Gas Burner."

The construction and operation of this portion of the Watkins' apparatus will be readily comprehended from the accompanying engraving and description, viz: A (Fig. 2), is the burner tip; B is the vapor chamber, provided with air holes at C; D is a conducting tube communicating with tube B; E is the generating space, in which the gasoline or naphtha is vaporized; F is the lighting cup; I is a connecting tube (metallic packed); and K is a valve, which is only closed when screwed down to the bottom without reference to how the handle stands. The other mechanical details are too obvious to require specification.

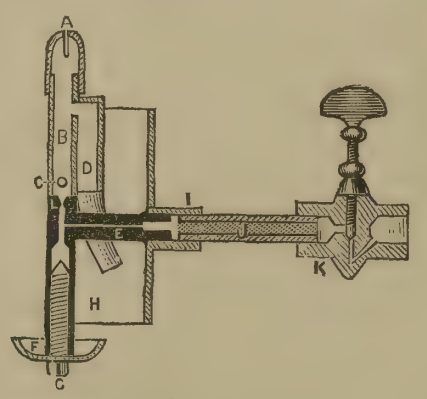


Fig. 2.

The operation of the burner is about as follows: We will premise that the valve K is closed, and the reservoir supplied with the needed quantity of gasoline (one pint for six hours' light). Some alcohol is poured into the cup, F, and ignited. After a few seconds, long enough to allow the burner to become heated, the valve, K, is opened. The naphtha passing through the packed connecting tube, J, into the space, E, which has become somewhat heated by conduction, is at once vaporized, and emerges into the chamber, B, through the needle hole, L. On passing through the needle hole, L, the ascending vapor current induces an air current which enters at the air holes, C, and is thoroughly mingled with the vapor in the chamber, B. The object of this device is to dilute the vapor, which is so rich that it would otherwise give a smoky flame. When the valve, K, is opened, as before described, the gas emerging at the burner tip is inflamed. The arrangement of the burner is such that a slight excess of vapor is always generated, which excess not being able to pass out readily at the burner, passes down the tube, D, and burns in jets directly under the generating space, E. These jets supply sufficient heat to insure a continuous generation of vapor so long as the supply of oil holds out. The shield, H, protects the jets from the wind, and the upward draft of air through the shield causes them to ignite again whenever they are blown out.

From this description will be seen that the burner acts the part of a gas generator, and it is stated to be the only device of this description that is supplied with heating jets directly under the naphtha feed tube, through which the liquid passes into the burner. By this arrangement there is insured a continuous and perfect generation of gas, and a very steady and brilliant flame, equal to that of the best coal gas. The burner is simple in construction, consisting of two pieces, readily detachable from each other, and can be made with or without the needle-screw, which regulates the size of the flame.

The material used with the device is stated to be re-distilled naphtha, one pint of which, it is affirmed, will be sufficient to supply the burner for six hours at a cost of less than two cents, and which, from the peculiar self-generating feature of the burner, is not in the least affected by any degree of cold. The naphtha reservoirs are made of a capacity to burn fourteen hours—the length of the longest winter night—but they can be gauged, of course, to be burned any number of hours that may be desired, and by putting into the reservoirs the desired quantity, they possess the advantage of extinguishing

themselves, at the proper time when the supply is exhausted.

The Watkins' is affirmed to be the only reservoir for street lanterns which empties itself by having its bottom inclined downwards to the discharge pipe, thus preventing any accumulation of liquid to remain and become unfit for burning.

The apparatus has been in practical operation for several years, and is said to have been adopted with satisfactory results in more than 100 towns throughout New England.

On the score of convenience and cheapness, the device would seem to be excellently adapted for towns and villages remote from the supplies of coal gas, for which it affords an admirable substitute. W.

ENGINEERING—CIVIL, MECHANICAL, &c.

THE HELL GATE BLAST.

The morning papers of the 26th inst., give detailed accounts of the successful accomplishment, on the afternoon of the 25th, of this great engineering feat—the destruction of Hallet's Reef. From the Philadelphia *Times* we extract the following:

"Early in the morning General Newton and his assistants began arranging the final details of the work on which they had labored for seven years. The vast cavern that had been excavated under three acres of rock and water, at an expense of over a million and a half of dollars, had been charged with fifty-two thousand two hundred and six pounds of dynamite, rendrock and vulcan powder, and then flooded with water, the cartridges being connected by wires with the battery outside. The great crane and all movable machinery had been taken to places of safety, and only a few trusted helpers were allowed to remain near the shaft.

At eleven o'clock, fearing that the action of the water in which they were submerged and the rain that had lasted for two days might have effected the wires, Mr. Streidenger, chief electrician, tested them from the battery. It was a hazardous experiment, for a hair's breadth, more must have exploded the mine. The wires were found to be in perfect condition, and at two o'clock another wire was carried from the battery along the shore and over the fence to Pot love, and there a second battery was arranged under a shed, and the wires fixed so that by pressing on an ordinary Morse telegraph key the electric spark would be shot under Hell Gate into the cartridges. A company of soldiers guarded this key, "for," said General Newton, "if any one should touch it a terrible accident might follow." There was little else done at the works, and all then patiently waited for the instant of flood tide, when the mine was to be exploded. * * * *

There had been the wildest diversity of opinion as to the probable results, some expected to see Astoria's buildings blown down and the air rent with a shock that must be heard many miles around. Others looked for a jet of water to be tossed in the air, and little or no report. Newspapers discussion had stimulated curiosity. That thousands of New York residents feared that buildings in the city would be thrown down was evinced by the fact that they forsook the houses as the minute of explosion approached, and despite the driving rain, went to the parks, and to the centre of the streets. Ten minutes before the blast was discharged a second gun was fired. General Newton then entered the battery room with his assistants, and the elements of the battery were lowered into the fluids, which action completed the circuit save at the key, six-hundred and fifty yards away. All was then ready, and it remained only to press the key to explode the 52,000 pounds of explosives. General Newton and his assistants hastily boarded his little steam launch and steamed away up the shore. There was real danger then, and they were in a hurry to get away from it. They thought that they had driven every person from the spot, but one enterprising dare-devil reporter, who had braved bullets on the battle-field, had crawled into the empty shanty where the dynamite had been stored, three hundred feet from the shaft, and had braced himself for the shock.

General Newton went to the little shed in which was the key, and there met his wife. Their nurse held the General's little two-and-a-half year old daughter, Mary, in her arms. The General looked at his watch, then at the tide, which was flood, and gave the signal for firing the gun, two minutes before the shock. The nurse then held little Mary close to the key. Mrs. Newton took hold of the child's tiny wrist, and, at the word from her husband, placed the child's hand on the key and the spark flew over the wire. The earth trembled and a great volume of water was hoisted seventy feet into the air. It first looked like spray; then it had a definite water color, and then came a pillar of muddy, murky black water. The discharge of cartridges was not simultaneous, and for at least ten seconds the mass seemed to hang in the air, then it fell and a great wave rolled away from the spot. The reporter near the shaft says the earth shook beneath him and almost stunned him. The water parted and was lifted in great spouts where the channels had been cut under the rock. Only a few stones were thrown up, but one mass of rock, weighing at least sixty tons, was lifted high in the air as gently as a balloon rises, and hanging suspended an instant was lowered as easily into the water again.

The multitudes shouted, scores of steam whistles blew salutes and General Newton's friends overwhelmed him with congratulations. Engineers and everybody saw that the work had been completely done, and pronounced it one of the most successful engineering exploits of the century. General Newton said he was satisfied that the work intended to be done had been completed. The shock was not great on the islands, and in Astoria, where the greatest damage had been anticipated, not a window pane was cracked, The jar throughout the city was plainly felt, and even in Paterson and Newark it was experienced, but no damage was done to property anywhere. A shanty close to the shaft was blown over, but not broken. The electric spark that exploded the mine carried the news of the explosion to different cities, a circuit having been formed, and it was made useful in certain electric tests.

After General Newton had assured himself that there could be no after explosion, the guards were removed and the multitude allowed to visit the work. They broke the wires in pieces for mementoes and carried off everything they could lay hands on. Soundings were immediately begun, and the reef will be buoyed without delay."

It is well worthy of notice that the N. Y. *Daily Graphic* published a photo-lithographed illustration of the explosion within twenty-four hours of its occurrence.

The Channel Tunnel.—The soundings for the proposed channel tunnel terminated at the end of August, and, it is said, have yielded most satisfactory results. [*Iron* viii, 301.]

Concession for the Darien Canal.—At a late session of the *Société de Geographie,* Lieut. N. B. Wise announced that a considerable company of gentlemen, under the presidency of M. le General Türr, had obtained a concession from the Columbian government for an interoceanic canal across the Isthmus of Darien. Mr. Wyse, who has been occupied with the study of the canal question for a considerable time and who is familiar with the region in question, proposes to start with a scientific commission in November, to make a thorough survey of the proposed line, between the gulfs of Uraba and of St. Miguel. The commission, on its return, will prepare a chart of the canal, and an estimate of its probable cost, which will be the basis of an international company which it is proposed to form, to carry the project into execution. [*Le Technologiste,* Aug. 26, 1876.]

MINING, METALLURGY AND MINERALOGY.

—The *Lehigh Register* says: The Lehigh Zinc Company, of Bethlehem, is about contracting for the purchase of a large amount of zinc ore from the New Jersey zinc companies. The amount is stated to be 12,000 tons per annum for a term of years. If the contract can be effected on satisfactory terms mining operations in the mines at Friedensville will be discontinued.

The Sherman Process continues to attract attention The reports of technical societies, and the journals devoted to metallurgy, republish the communications that Sherman has been induced to make on the subject of his invention.

We have ourselves, in one of our late numbers, published the essential parts of a communication made to the Society of Civil Engineers of Paris. Another communication, in terms almost identical, has been presented to the Society of Mineral Industry of St. Etienne, at its session of 5th of last August.

There is found there a positive contradiction of the Sherman process. M. Euverte, of the Terrenoire manufactory, positively declares that he does not believe in the Sherman process, and he gives his reasons for this assertion. The inventor and his supporters reply by other arguments.

As one affirms, and the other denies, with the same positiveness, the question would remain a long time undecided, and the discussion become interminable, if the facts and the practical working of the process, had not cast light on this question so closely connected with the progress of metallurgy.

We thought it right to obtain direct information; and now present to our readers an abstract of the information which we have collected.

The Sherman process has been used in the valley of the Loire for nearly a year, notably in the large steel works of Firminy. More than 20,000 tons of steel have been made by the Sherman process in this establishment, and the results obtained are now no longer doubtful.

Steel made by this process undeniably posseses special properties. It has more tenacity, is more ductile, and offers greater resistance to traction.

The process consists, as is well known, in the introduction, at the proper moment, of a small quantity of potassium iodide, about 30 grammes to the ton of metal.

How does it act? is the question which theoretically does not appear to be explained. But look at the facts which are presented to us as certain.

We know that cast-iron and wrought-iron containing phosphorus, and old railroad iron, can only be used in a very small proportion in the fabrication of steel. There has been, and it is still, a great difficulty in transforming old iron rails into steel rails. Up to the present time, not more than 5 per cent. of old rails can be employed.

Now, with the Sherman process there is employed at Firminy, in the manufacture of steel rails, at least 50 per cent. of old iron rails, and a superior quality of steel is obtained. Without in the least changing the method of manufacture, at the ordinary speed of the furnaces, and with a mixture of 50 per cent of old iron rails, they proceed until the moment when the melting takes place.

If, at this moment we take an instrument called an éprouvette or prover, we can verify, that the metal is absolutely worthless; it is a valueless material, neither iron nor steel. The matter crushes under the hammer, and the metal produced breaks at the least shock.

If, after this trial, the Sherman process is applied, the metal is transformed, the influence of the impurities which prevented the manufacture is neutralized, and an excellent steel is obtained, having, as we have said, peculiar properties and qualities.

The fact either exists, or does not exist. If it exists, which from our information is not to be denied, what becomes of the objections which have been presented with so much persistence against the Sherman process?

We were obliged to give prominence to this example of a particular manufacture, because every one knows that the question of the conversion of old iron rails into steel, is an important problem for the solution of which metallurgists have not ceased to employ their efforts and their researches.

It is well known that, at Firminy, with ordinary furnaces and iron, steel is obtained for tools, displaying unusual excellence and strength. [*G. Lestang, in Revue Industrielle,* vii. 362.]

The Sutro Tunnel has struck 40 inches of water in its headings, now over 14,000 feet from the mouth. This is thought to be indicative of a vein not far off. As is well known, there are two large outcrops on the line of the tunnel, before the Comstock itself is reached. [*Eng. News* iii, 307].

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Cosmical Chemistry is a science of yesterday; and yet it already abounds in facts of the highest interest. *Hydrogen,* which, if the absolute zero of the physicist does not bar the way, we may hope yet to see in the metallic form, appears to be everywhere present in the universe. It exists in enormous quantity in the solar atmosphere, and it has been discovered in the atmospheres of the fixed stars. It is present, and is the only known element of whose presence we are certain, in those vast sheets of ignited gas of which the nebulæ proper are composed. Nitrogen is also widely diffused among the stellar bodies, and carbon has been discovered in more than one of the comets. On the other hand, a prominent line in the spectrum of the aurora borealis has not been identified with that of any known element; and the question may be asked:—Does a new element, in a highly rarified state, exist in the upper regions of our atmosphere? or are we, with Angstrom, to attribute this line to a fluorescent or phosphorescent light produced by the electrical discharge to which the aurora is due? This question awaits further observations before it can be definitely settled, as does also that of the source of the remarkable green line which is everywhere conspicuous in the solar corona. [From Inaugural Address of Dr. Thomas Andrews, President of British Association.]

Concerning Ink.—The observation of Runge, that a dilute solution of logwood, to which a small quantity of neutral chromate of potassa is added, produces a deep black liquid suitable for writing ink, has been extensively utilized. It is found, however, that upon exposure to the air, this liquid often decomposes rapidly and deposits its coloring matter in the form of large black flakes, leaving the supernatant liquid colorless. This peculiar behaviour, is the great fault of this ink, which in other respects possesses all the qualities essential for a good ink; inasmuch as it is very cheap, readily prepared, does not corrode steel pens, and penetrates paper so thoroughly that the stain cannot be removed, even by washing with a sponge. Bœttger has lately suggested a plan by which, he affirms, this difficulty from stratification and deposition may be effectually remedied. The remedy he finds in the addition of carbonate of sodium (ordinary washing soda). He recomends the following formula for the preparation of the ink, which he affirms will produce a liquid of a fine bluish-black color, which will flow readily from the pen, dry readily, and not decompose, viz: Extract of logwood 15 parts, water 1000 parts, crystallized carbonate of sodium 11 parts, neutral chromate of potassium 1 part. Dissolve the

logwood extract in 900 parts of water, allow it to deposit, decant, heat to ebullition, add the soda; lastly add, drop by drop, with constant stirring, a solution of the neutral chromate in 100 parts of water.

A New Adhesive —An adhesive which, so far as color and durability is concerned, is affirmed to surpass that made from gum arabic, is made according to the following recipé, viz:— Milk is curdled by the addition of acetic acid (vinegar) and the precipitated casein after being thoroughly washed with fresh water, is dissolved in a cold, saturated solution of borax. The result is a clear solution of syrupy consistence, possessing upon drying a fine lustre, and high adhesive qualities. This adhesive is recommended for a variety of uses. [*Beiblatt zum Phœnix*, Sept. 2, 1876.]

For the Protection of Workmen who are obliged to handle lead and mercury compounds, the French Chemist Melsens recommends daily, but very small doses of iodide of potassium taken internally. Melsens affirms that this substance dissolves the lead or mercurial compounds that are absorbed in the system, and effects their rapid removal. [*Der Metallarbeiter.*]

Fuchsin in Red Wine.—The alarm expressed in the daily press of Germany, concerning the alleged artificial coloration of the French and other wines with aniline colors, is declared by Herr Reimann to be quite groundless. He reminds the alarmists that the use of arsenic in the preparation of fuchsin is by no means so general as formerly, and that most of the large factories dispense with it entirely, For the further consolation of the lovers of astringent wines, he remarks that, even supposing this species of adulteration to be generally practiced, the amount of fuchsin required to give color to wine would be but the one hundred thousandth of one per cent., a quantity so small that it would be practically harmless, even if it were pure arsenic. To detect fuchsin, he explains that it is only necessary to add to the wine a few drops of dilute sulphuric acid and a little aldehyd, when if it is present, a superb color will result, which no other coloring matter is known to produce. [*Reimann's Färber Ztg.*, No. 34, 270.]

MISCELLANEOUS.

The Parakite Flying Machine.—Some further experimental trials were carried out on Chatham lines last week, under the directions of the members of the Royal Engineer committee, for the purpose of testing the adaptability of employing "parakite" flying machines for reconnoitring purposes with an army in the field, as proposed by the inventor, Mr. J. Simmons, civil engineer and aeronaut. The machines may be described as gigantic kites, the largest of which had a surface area of 25 feet square. The wind had a force of between four and five, with velocity of about ten miles an hour, and was, therefore, highly favorable for the trials. Each of the parakites, is composed of the best French cambric, covered over with a mixture of bird-lime and india-rubber, which has the effect of rendering it as nearly as possible air-tight. From the extremities of the square are light poles, placed on sockets, which spread each parakite to the required area. The first parakite sent up was about eight feet square, and this soon rose to the required height. The desired altitude being obtained, the parakite was fastened to another of the same description but somewhat larger in area. A third and a fourth parakite, each larger than the other, were sent up, the highest at this time soaring to a height of about 1200 feet. Unfortunately, at this juncture, the pole of the fourth parakite snapped, and, after a failure in fitting another, the disabled parakite was removed, and arrangements at once made for raising the largest of the parakites, which had an area of between 600 and 700 square feet, But before this last parakite was sent up, a trial was made of the lifting powers of those already elevated, when it was found they had lifted a drummer boy with ease. After a brief interval the largest parakite was attached, and was soon soaring to a height of several hundred feet, a dozen sappers of the Royal Engineers holding on to the ropes, the four parakites having a strain calculated at a little short of a ton. Captain M. T. Sale, one of the instructors in field fortifications, promptly made the trial of the lifting powers of the parakites, and was instantly raised by the ropes several feet from the earth. Almost immediately afterwards the rope holding the parakites gave way from the immense strain, and the whole came to the ground. After a brief interval a trial was made alone of the largest but one of the parakites, the largest having been placed *hors du combat*, when it raised a bag of sand weighing half a hundred-weight to a great height. This terminated the trials, which were so far satisfactory that they, it is deemed, have proved how in those parakites a reconnoitring party might be raised to a moderate height, to enable them to watch the manœuvres of a hostile force. Before, however, the invention can be brought into practical use, not a few improvements and modifications, it is stated, will required to be made. [*Iron* viii, 300.]

An Exhibition will be opened on the 10th of April, 1877, at Sydney, New South Wales, which should have considerable interest for Americans. Gotten up under the auspices of the Agricultural Society of New South Wales, it will consist of two main divisions, the first embracing cattle, farm produce, horticultural produce, implements and machinery, etc., etc. The second, or non-agricultural division, comprises fine arts, apparatus and processes used in the common arts, products of mining industry, forestry, food, furniture, etc. From the list we have given, and which by no means covers the whole of the sub-divisions, it will be seen that the objects to be exhibited embrace a pretty comprehensive field, and it has been thought that the present would be a fine opportunity for an effort to be made to develop business between Australia and the United States. Endowed with a fertile soil, a fine climate and but thinly inhabited, the economic conditions of Australia are analogous to our own. Labor commands high prices, money is abundant and the inhabitants, as generally in new countries, are ready to spend it on improvements and machines for diminishing human labor. Large numbers of Australians come over here *via* San Francisco; they admire our labor-saving apparatus, but they do not generally belong to the agricultural class, which is the one that would derive most benefit from the acquisition of our reapers and binders, our fruit-drying apparatus, our fruit presses, potato-diggers and the thousand and one mechanical appliances which time and expereince have shown to be best adapted to a land where the harvest is great but the laborers few. Such being the case it is suggested that our agricultural implement makers and manufacturers would do well to be represented at the coming exhibition. There climate and conditions of labor are the same; those mechanical appliances we have adopted here ought to be equally serviceable in Australia, and as Sydney is, so to say, the central point where, especially next April, the agricultural interests will converge, the present would seem to be a favorable occassion for the experiment to be made. Sydney is but twenty-eight days by the regular mail steamer from San Francisco, which, it may be mentioned, goes straight across to that port. Another route is *via* the Isthmus of Panama, but for the freight from the Eastern coast sailing ships from Philadelphia, New York or Boston to Sydney may readily be obtained at low rates. As every true patriot must welcome any fresh outlet for his country's productions, so we believe that in the present depressed state of trade the Australian trade may be found a most useful debouche for such articles as we have named, and others, such as cotton manufactures, in the exportation of which a beginning has been made. There are no import dues in New South Wales, and hence our exporters run little risk, while the prospect they have of initiating a new and profitable trade is sufficient to warrant their going to some expenditure of time and money. From a circular just issued by Mr. Charles Robinson, the secretary of the New South Wales Commission at the exhibition, we see that with a white population of 2,500,000, Australia is able to import annually goods to the value of about $250,000,000. Hitherto England has reaped the chief benefit of this trade, but we have shown that we can import our own goods into England, and we firmly believe we can compete with her successfully in Australia. Time alone can show this, and the opportunity of making the experiment is afforded by the exhibition we have been speaking of.

The new life-saving stations on our Lakes, nine of which have been or are to be built this year, are 20x45 ft., 1½ stories high, with two rooms in the first story and four above. On the roof is a walk-way and look-out. The roof is painted red and the side lights drab trimmed with a darker shade. These stations are to be furnished with life-boats and all the requisite appliances for saving life, amounting in value from $2,000 to $3,000. A crew will be employed during the season of navigation, the station to be in the charge of one man during the winter. [*Eng. News*, iii, 307].

The American Boot and Shoe Exhibit.—A German expert, writing from Philadelphia, to the *Schumacher Zeitung* of Berlin, affirms that not more than one-third of the machinery on exhibition in this branch of the Centennial, is known to Germany; "all the rest," he adds, "are new inventions, and show an amount of progress that will soon revolutionize our whole trade. It is remarkable that the Americans are the only ones in our branch of industry who have brought out something new. England and France are on the old hobby. The American industry is obviously developing its peculiar genius and strength, which command our admiration. * * In a few years these Yankees will supply Germany with boots and shoes instead of receiving them from thence."

—We regret to see that the Italian African Expedition has been so badly treated in its progress southwards, that Captain Martini has had to go to Rome, deputed by the Marquis Antinori, to request assistance. Most of their baggage has been stolen or destroyed, and every possible obstruction thrown in their way. [*Nature*, Sept. 14th, 1876.]

The Coming "New World."—Lieutenant Cameron, of the British navy, who recently returned from a two years' exploration of Central Africa, reports the discovery of something more valuable than big monkeys and little "niggers." He found the portion of Africa west of Lake Tanganyika to be one of the richest countries in the world, and more salubrious than India. Ivory is there found in greater abundance than anywhere else. At Nyangwe, the Arabs trading among themselves give thirty-five pounds of ivory for seven and a-half pounds of beads or five and a-half pounds of cowries, and very often they are able to buy a tusk irrespective of size, which may weigh from 100 to 150 pounds, by the present of a copper bracelet, or any worn-out, useless thing which may take the fancy of the natives.

Lieutenant Cameron says he has walked along for fifty or sixty yards under a grove of nutmeg trees, and no one knew what they were worth. Besides that, there are many other vegetable products in abundance, many different species of cotton, and oil-producing palms. Up the valley of the Congo, to the height of 2,600 feet above the level of the sea, the country was crowded with oil-palm, and hereafter that trade alone, leaving the question of ivory altogether on one side, would be sufficient to repay any enterprising merchants who embark in it.

Gold is also found, and Mr. Cameron saw an Arab who showed him a calabash full of nuggets, which were all procured in one evening in clearing out an old water course. Iron, copper, silver and tin are abundant. All this, the Lieutenant thinks, may easily be reached by the great Congo and Zambesi rivers and their tributaries, two of the most magnificient systems of water communication in the world. A little canaling seems to be all that is needed to form a water communication between the east and west coasts of Africa, and so make all her rich resources available for trade. [*Am. Manuf.* Sept. 21st. 1876.]

The Krupp Iron Works.—It may interest our readers to know that these works, located at Essen, Rhenish Prussia, employ in the steel foundries 10,500 men, and in the mines and forges 5,000. In the steel factory there are 1,648 furnaces of various kinds in full bast, 208 steam boilers, 77 steam hammers, 294 steam engines of from one to two thousand horsepower, and 1,093 other machines. In the year 1875 the manufactory consumed 612,000 tons of coal, 4,500,000 cubic metres of water, 7,500,000 cubic metres of gas, suplying 22,432 burners. The means of transport and communication comprise 25 miles of railway, with 14 engines and 537 trucks; 11 miles of narrow-gauge rails, with 10 engines, 210 trucks, 80 horses, and 214 wagons, and 38 miles of telegraph wires. The mining department sees to the working of the 414 shafts which are being worked in Germany, exclusive of those belonging to the Krupp Company in the North of Spain, the minearls from which latter place are conveyed in four steamers with a total tonnage of 1,700 tons. The practice-ground for the guns made at Essen is at Dulmen, and it is nearly five miles long. [*Saward's Coal Trade Journal*, xii, 155.]

The programme for the next French International Exhibition, 1878, has been published in the *Journal Officiel*. The regulations are substantially the same as in former exhibitions. The building is to be a long parallelogram, and will divided into rectangular stripes, two of these stripes being allotted to special divisions, one for France, and the other for foreign countries. Fine arts will enjoy the central stripe, and consequently be an exception. Right and left will be placed the two stripes allotted to scientific industries, under the name "Education, Teaching, Methods and *Materiel* of Liberal Arts." Amongst the principal attractions of the Exhibition will rank a gigantic Giffard steam captive balloon. It will measure 21,000 cubic metres, and exceed by 10,000 the former captive balloon at Ashburnham Park. The rope will weigh 20 pounds per yard, and the elevation will be 500 yards. The steam-engine will have 200 horse power; thirty persons will ascend at once, and in calm weather, 100. The new captive balloon will require no circus for protection, and will stand in the midst of a large square fronting the bridge in the central alley of the gardens. Meteorological observations, with special instruments, will be made during the ascents for the instruction of excursionists, and recorded for the benefit of science. [*Nature*, xiv, 443.]

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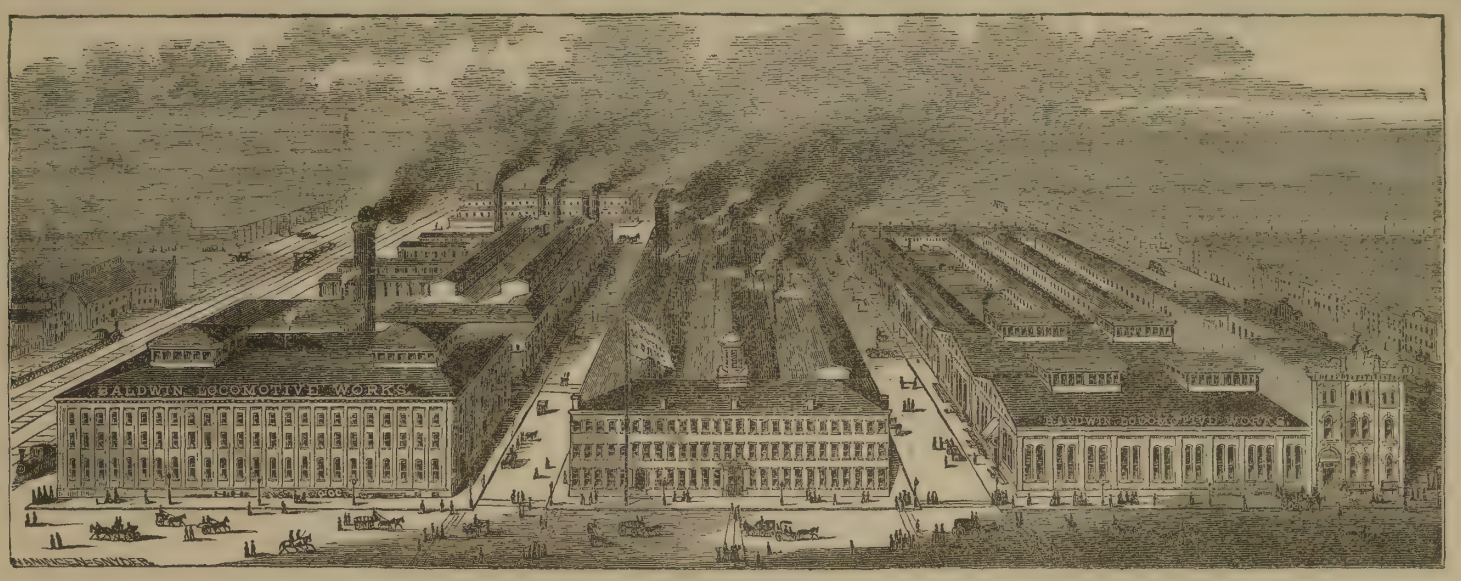
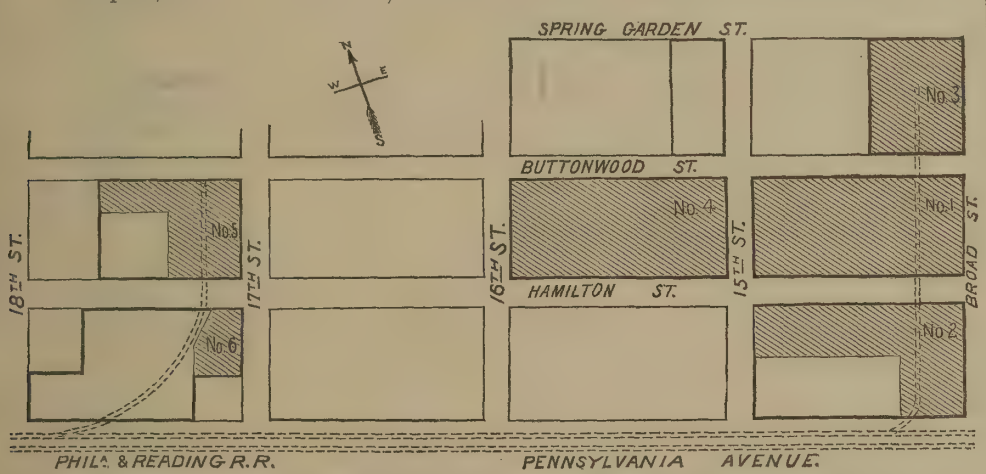


THE BALDWIN LOCOMOTIVE WORKS.

CENTENNIAL EXHIBIT OF THE BALDWIN LOCOMOTIVE WORKS.

VII.

The Baldwin Locomotive Works are situated with a front on Broad Street, Philadelphia, extending from Pennsylvania Avenue to Spring Garden Street. They also comprise one block bounded by Fifteenth and Sixteenth, Hamilton and Buttonwood Streets, and the greater part of two blocks between Seventeenth and Eighteenth and from Buttonwood Street to Pennsylvania Avenue. The plan below shows the area occupied, over nine acres in all, of which between six and seven acres are under roof.



1. Office, Drawing Room, Boiler Shop, Machine Shop, and Blacksmith Shop. 2. Machine Shop, Blacksmith and Hammer Shop, Pattern Shop, and Paint Shop. 3. Erecting Shop. 4. Iron Foundry, Brass Foundry and Shop, and Blacksmith Shop. 5. Machine Shop, Tank and Sheet Iron Shop, and Wood Shop. 6. Spring Shop.

NOTE.—The ground occupied by the Baldwin Locomotive Works is inclosed in heavy lines; shaded spaces indicate buildings.

The Works were founded in 1831 by the late Matthias W. Baldwin, and have been in operation continuously since that date. Thirty-eight hundred and eighty-six locomotives were constructed up to May 10th, 1876, the greater part for railroads in the United States; the remainder for railroads in Canada, Nova Scotia, Prince Edward Island, Cuba, Mexico, Brazil, Buenos Ayres, Costa Rica, Peru, Chili, Germany, and Russia.

The capacity of the Works is five hundred locomotives per year. The greatest production was in 1873, when four hundred and thirty-seven locomotives were completed, one hundred of which were for exportation. Three thousand men were employed during that year. The ordinary force is from fifteen hundred to two thousand men. All parts of locomotives and tenders, except the boiler and tank plates, the steel tires and steel forgings, chilled wheels, boiler tubes and some of the furniture are made in the works from the raw materials. The plant comprises seven hundred and twenty-seven machine tools, many of them designed and constructed to meet the special requirements of locomotive work. All important parts of locomotives are made to gauges and templets, ensuring absolute uniformity and interchangeableness in like parts of engines of the same class.

Designs are made to meet every description of service to which a locomotive can be applied, from the heaviest freight locomotive, weighing one hundred thousand pounds, to the smallest locomotive, weighing only fourteen thousand pounds, for mines, manufactories, or street railways. Drawings and patterns for over three hundred classes of locomotives are comprised in the practice of the works.

In six of our previous numbers, illustrations and descriptions are given of several locomotives forming the exhibit of the Baldwin Locomotive Works in the Machinery Department of the International Exhibition of 1876.

This firm recently completed its 4000th locomotive; the event being celebrated on the 28th ult. (Pennsylvania Day) by a visit of the employés of the Works, in procession to the Centennial grounds.

THE INTEROCEANIC CANAL.

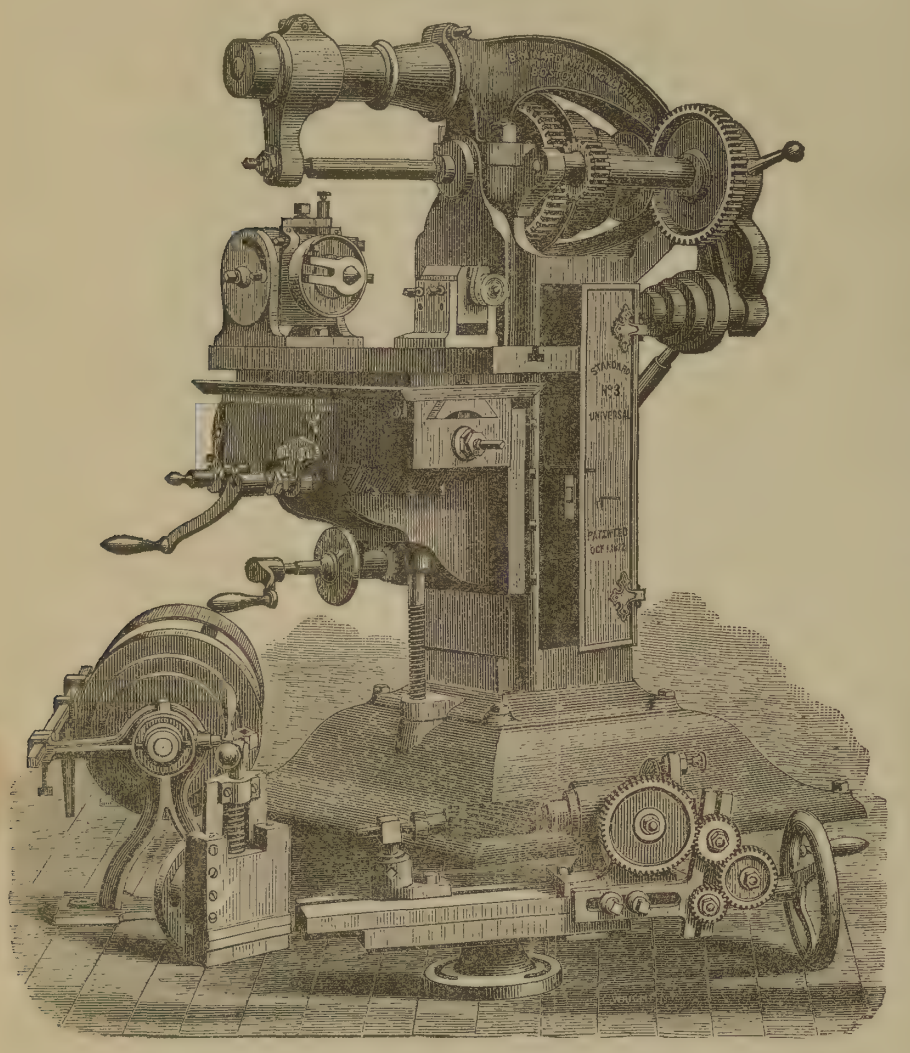
In August, 1875, the International Geographical Congress, at its second meeting, held at the Tuileries, Paris, took up the question of the canal across the American isthmus. Several gentlemen, among them some who were interested in their own particular lines, addressed the meeting on this important matter, but the result of it was that no definite conclusion was reached. The Congress then passed the following resolution, which was proposed by Mr. Ferdinand de Lesseps: "That the governments of the different countries interested in this great work should give every possible encouragement to a thorough study of it, and that their attention should be particularly devoted to those routes which offer the greatest advantages to navigation from their accessibility and from the few obstacles in passing through them."

At the same time that this resolution was passed I presented a paper in which I summed up the result of my studies for five years, taken from all the documents and reports I could find in relation to the proposed canal. In this paper I endeavored to put entirely out of sight all personal feeling, as well as any that I as a Frenchman might have in regard to my country. Convinced as I was that a work of such importance should interest all the nations of the world, I confined myself to a general and purely scientific study of the enterprise, and, as the work was to be international, I invited men of science all over the globe to aid me in deciding which route for the proposed ship canal would, under the circumstances, be the most advantageous for all nations. The Commission of Commercial Geography, and the Geographical Society of Paris have, in compliance with my appeal, taken the matter actively in hand, and on March 24th, 1876, formed the French Section of the "International Committee to study the question of cutting a canal through the American isthmus." Among the members of this section can be mentioned the President, Mr. Ferdinand de Lesseps, Manager of the Suez Canal Company; the Vice Presidents, Mr. de la Roncière de Noury, Senator, Vice Admiral and President of the Paris Geographical Society, and Mr. Meurand, Director of the Consulates in the State Department, and honorary President of the Paris Geographical Society, and the Secretary, Mr. Léon Drouillet, an engineer, member of the Paris Geographical Society and author of the proposed organization. From March 24th the French section has had its office at No. 9 Rue Clary, Paris, in one of the rooms of the Suez Canal Company's building, which Mr. Ferdinand de Lesseps has been so good as to put at its disposition, where can be found all the papers and documents on the subject, and where all correspondence should be addressed. The French section has received subsidies from several departments of the government, and has entered into relations with all the geographical societies in the world of whose existence it is cognizant, begging them to co-operate in the work, and to have sections named in their respective countries similar to that in France. Most of the geographical societies of Europe have already appointed their sections, and, from the resolutions they passed in doing so, will be represented at the first meeting of the International Committee at Paris some time during the month of November next. The American Geographical Society of New York has had no regular meeting since the plan has been offered to its consideration, but the French Geographical Society, seeing the importance of obtaining especially the co-operation of the kindred society in the United States, has commissioned me to go to America to do what I can to see that

the American section should be formed as soon as possible. Mr. Nathan Appleton, of Boston, a gentleman who for many years has been interested in the canal question, went with me to call upon Judge Daly, the president of the American Geographical Society, who received us most courteously. He said that at its first meeting in October the American Geographical Society would take into consideration the formation of an American section; that there was every probability that one would be formed, and that he thought that measures would be taken to have the society represented through some of its members at the meeting of the International Committee to be held in Paris in November next. Judge Daly added, in respect to a letter I handed him from Dr. Johnston, the well known American physician in Paris, that he would undoubtedly be one of the members of the American section, if formed, as he stood very high in the estimation of the society.

LEON DROUILLET,

Secretary of the French Section of the International Committee to study the question of cutting a canal through the American Isthmus.



NO. 3 STANDARD UNIVERSAL MILLING MACHINE.

(BUILT BY THE BRAINARD MILLING MACHINE CO.)

This machine has all the movements and power of a plain milling machine, but much greater range and capacity, and can be applied to an almost endless variety of work quite impossible with other machines. The driving cone is full back-geared, giving six changes of speeds, and takes a 2½-inch belt. The knee, upon which is mounted the carriage and work table, has a perpendicular range of 18 inches, and can be set at any height by means of its dial-plate to the *one-thousandth of an inch.* The carriage above has a cross motion of five inches. The work table is T slotted, both lengthwise and across; the slots all milled to a gauge, perfectly true and square; the table has an oil channel all round it, and can be fed by hand from either end, or automatically; length of feed 18 inches, with stop to detach at any point.

The main arbor or spindle is of solid steel, 4 inches in diameter at its largest part, with true anti-friction curve on its front end, and if properly cared for, will never bind, work loose or wear out of true. The spindle has a 9-16 hole through its length, and screw for chuck or jaw plate on front end.

Above the spindle is a large arm, carrying an outside centre support, so that cutters can be used 15 inches from front of machine; the arm is detachable.

The feed work has four changes, and is undisturbed by any movement of knee, carriage or table. The feed-belt can be tightened without unlacing.

Proper provision is made for wear of running parts and the taking up of slack motion, especially in the feed work.

The machine is superbly finished and fitted with the utmost accuracy and care. The feed-screw and all the gib, set and cap screws are of steel, the feed-worm and worm-gear of tempered tool-steel: the feed-screw runs in bronze bushings, and bronze collars are interposed between bearings to obviate wear. It is built from new patterns, combining many conveniences and improvements suggested by years of daily practical use, and in connection with its attachments is a marvellously comprehensive machine. Its weight without attachments is about 1500 pounds; complete, about 1900 pounds.

The attachments comprise a rotary vise, a spiral cutter and a universal head, with its complement of a back centre, and an extra table for taking in long work. The rotary vise has jaws 6 inches long, to open 3 inches; the jaws are held by steel screws passing through the vise with heads outside; it is held to the machine table by two bolts, and can be set at any angle. The spiral cutter will cut spirals 8 inches in length, right or left hand, and of any pitch, from one turn in 2 inches to one turn in six feet. There are four gears, making 8 changes; other changes, if needed, can be made with any lathe gears of 12 pitch by fitting a suitable bushing. Long twist drills can be cut by using a chuck on the spindle, which has a 15-16 hole through its length. The "universal head," with back centre and extra table, vastly increases the capabilities of the milling machine, (and can also be used on a planer to finish irregular work). By its use, spur and bevel gears can be cut, work milled at any angle, and in almost any position; taps and reamers fluted, and a multitude of other jobs done. Nine circles of holes in the dial-plate give 47 divisions, and additional dials increasing the number of divisions can be attached if desired. One of the sides is laid off in degrees so that the head can be set and worked at any angle. The centre is hollow, and the spindle takes a chuck of the same size as the spiral cutter and the machine proper. The back center accompanying the head is capable of elevation and depression. And of being set at an angle for convenience of finishing tapered work. The head and back centre are mounted on a table sufficiently long to take 18 inches between centres.

The engraving shows the "Universal Head," with the back centre and extra table in place on the work table. The spiral cutter and rotary vise are seen at the foot of the machine.

DIATOMS AS FOOD FOR PLANTS.

We have been favored, through the courtesy of Prof. Phin, the Editor of the American Journal of Microscopy, with advance proof-sheets of an article under the above-named title, containing severe strictures upon the statements made by Prof. P. B. Wilson, of Washington University, Baltimore, Md., concerning the value of infusorial earth as an ingredient of fertilizers for cereal crops.

Our readers will doubtless recall the fact of the publication in this journal of an article entitled, "Infusorial Earth and its Industrial Uses,"* in the course of which incidental allusion was made to Prof. Wilson's alleged discovery, which was in substance that, having examined the straw from wheat grown upon land fertilized with a manure of which infusorial earth was an ingredient, he found, upon placing under the microscope what remained of the straw after it had been treated with nitric acid, that it consisted wholly of the siliceous shields of diatomaceæ. Prof. Wilson alleged, in other words, that these diatoms, when incorporated with the soil, are taken up by the plant *as such*, without undergoing previous solution, and to prove his assertion he published an engraving illustrating quite a number of organic forms that he had detected. Upon the strength of these alleged observations, Prof. Wilson advanced certain conclusions greatly at variance with current scientific opinion, which we stated in the article in question, and which we reproduce here in his own words:—

"This investigation is final. It overthrows all theories that have ever been advanced, that silica enters into plant structure in combination with alkalies, the alkaline earths, or the earths proper. Chemical investigation led me to this conclusion some months since, now confirmed by that of the microscope. A new era has dawned upon the science of agriculture. By close observation and strict scientific investigation, *new information* will be brought to light to reward the tiller of the soil for his time labor and capital. * * * * These microscopic investigations show the absence of other forms of silica, that is, in granular particles in the (Kunkel) straw, they being entirely replaced by diatoms. This leads to the conclusion that the diatom is the more acceptable for assimilation—and when sufficient infusorial remains are present, replaces any other divided form of silica.

The result of these investigations shows the necessity of finely divided silica in the soil, so minute as to be capable of passing with facility through the sap cells; secondly, that simple or compound silicates are useless as fertilizing agents, either natural or artificially prepared."

While not sharing the opinions as to the significance of the presence of these organic forms in (Kunkel) straw, and expressing our doubts upon the accuracy of his inferences, (the character of our article not admitting of more than an incidental allusion to Wilson's discovery, as one of the many items of interest in connection with the uses of infusorial earth), we nevertheless did not presume to entertain a doubt as to the *genuineness* of Prof. Wilson's asserted observations. Nor did our learned contemporary, "The American Journal of Science and Arts," which admitted into its pages* an elaborate article by Prof. Wilson, bearing the title, "Silica of Grasses and other Plants carried up as Diatoms or other siliceous grains, and not in solution or as soluble silicates." The editors of that journal, equally with ourselves, took it for granted that Prof. Wilson's alleged discovery was based upon the truthful interpretation of a genuine observation made by a scientific investigator animated, by the desire to learn the truth, and having learned it, to impart it to his fellows.

Prof. Phin, in the article to which we referred at the outset, emphatically denies the genuineness of Prof. Wilson's alleged observations, and directly charges him (Wilson) with having *manufactured the observation* out of the whole cloth. The following extracts from Prof. Phin's article are sufficiently explicit upon this point:—

"A single glance at the engraving to which he so confidently refers, is sufficient to convince any microscopist that Prof. P. B. Wilson never saw "upon the field of his microscope," under the circumstances which he has described, the objects which he has delineated. This is a bold assertion, and a severe accusation, but the proof is simple and unimpeachable."

Prof. Phin then proceeds to establish his accusation of fraud, by showing that one of the forms (Bacillaria) figured on the plate, is figured as it exists only in the living condition (the organic matter, it will be remembered, has been destroyed by treatment of the straw with nitric acid), the frustules being joined together in the peculiar way which has given to this form the specific name *paradoxa*. "For this diatom," says Prof. Phin, "to have passed through a bath of nitric acid, and come out in the condition figured, would have been almost as great a miracle as passing Shadrach, Meschach and Abednego unscathed through the fiery furnace of Nebuchadnezzar." He (Prof. Phin) affirms also that a *calcareous* foraminifer is figured among the forms on Prof Wilson's Plate. If this be the case, we should require another miracle to have saved from destruction in the nitric acid, this particular object, for it is a fact of common knowledge, that carbonate of lime is energetically dissolved by nitric acid even in the cold. Finally, Prof. Phin appends to his own criticism, the statement of "one of

* *Vide* this Journal, Vol. 1, p. 43.

our ablest diatomists" (we regret that his name is not attached to his statements), who declares that the 36 forms, which Prof. Wilson has "carefully sketched," are composed of a *mixture* of marine and fresh water diatoms, sponge spicules, a little of the siliceous cuticle of straw, and a foraminifer. "*Only one form*," he remarks, "*belongs to the Virginia deposit, with which Kunkel's field was fertilized—and which is exclusively marine.*"

The fact that an editorial appeared in the REVIEW, containing statements founded upon the presumed truth of Prof. Wilson's alleged observations, and that this article has been extensively quoted, and reproduced in the home and foreign technical and scientific papers, is, we hope, a sufficient apology for admitting a matter of personal controversy to our columns. In the light of this explanation, therefore, we deem it proper and just to place this criticism without comment before our readers. The issue is raised upon matters of fact, the truth or falsity of which must be determined by those who have made the study of these microscopic forms, a specialty.

Prof. Wilson stands accused of the gravest of offences—the manufacture of evidence. It behooves him to "rise and explain." We await further developments.

W.

THE SCHUYLKILL WATER DURING LAST WINTER.

BY WILLIAM TRAUTWINE.

II.

To ascertain, if possible, the cause of superaëration, the writer visited the Belmont water-works, which supply West Philadelphia and north-western Philadelphia. The Belmont reservoir is fed by pipes from pumping works near the western end of Columbia Bridge. The water was closely watched as it entered the pumps from the sluice underneath the pumping house. It was taken up noiselessly, and without perceptible mixture with air. Much of the water from these pumps is thrown into Belmont reservoir through a fountain pipe, producing a pleasing effect familiar to Park frequenters. This aërates the water somewhat, but perhaps not sufficiently to account for the phenomenon. Besides, this fountain supply is not always in use, being used alternately with a supply pipe of the ordinary sort. An analysis of boiler-scale from the boilers of Belmont pumping engines, which are supplied with river water, showed the water here to be identical, as to suspended and dissolved matter, with that delivered from the Belmont reservoir in city houses.

Through the past winter, which, it will be remembered, was an unusually open one, a great number of new water main connections were made, particularly in West Philadelphia, anticipating Centennial improvements. This fact may possibly explain the mystery. It will be evident that, when water from a reservoir flows, under great pressure, into a long section of pipe, much of the air in the pipe, if unable to escape, will be dissolved; particularly, if the water be cold; and the phenomenon was especially one of the winter. The same phenomenon, too, has been noticed at times, particularly in winter, in parts of the city supplied from other reservoirs. The superaëration is beneficial, as by means of it organic impurities prejudicial to health are at least to some extent, oxydized, and partially eliminated.

For the purpose of deciding whether any substances held in solution or suspension by the water accounted for, or were in any way related to, the phenomenon, several rough quantitative analyses were made of water from both hot and cold faucets.

The total residue obtained by evaporating one gallon of clear water to dryness (repeated experiments), was about seven grains. Half this residue, say 3½ grains, redissolved in warm water; its composition was:

Sulphuric acid, trifle over	1 grain
Lime, trifle less than	1 "
Magnesia, about	½ "
Chlorine, about	¼ "
Soda, trace, undetermined	
Per-oxide of iron and alumina, traces	¾ "
Loss including some organic matter..	

Most of these substances existed in the water combined with each other; chiefly as sulphates of lime and magnesia, and as chlorides of sodium and magnesium.

The 3½ grains *insoluble* half of residue were principally silicate of alumina and silicate of magnesia, clay, and earth, with some siliceous sand, peroxide of iron, and traces of carbonate of lime and organic matter.

These imperfect examinations sufficiently determined the comparative purity of the water, and proved that no unusual matter excepting air was contained in it, to which the phenomenon in question could be referred. The results obtained were not materially different from those reported in former analyses by Professors Cresson, Booth and Garret, Boyé, etc.

As shown by these analyses in the report of the Water Department for 1874, and of the late committee of experts on water supply, the proportion of solid matter dissolved or suspended in the Schuylkill water has been steadily increasing for some years past, having been but about four and a half grains to the gallon in 1842. This increase is chiefly in sulphate of lime, formed from the union of sulphuric acid, derived from decomposed iron-pyrites in coal-mine drainage, with lime from limestone beds over which the river and its tributaries flow near Reading. No danger to health need be anticipated on this account at present, but the proportion of sulphate of lime is sufficient to perceptibly decompose soap; the resulting insoluble lime-soap,—which represents so much wasted soap—forming a white curd about the sides of a basin.

The proportion of sewage, however, has at times been so great as to be disgusting to the senses if not prejudicial to health, a little being more than enough. The residue, from evaporating the water in question to dryness, by which process some volatile organic matter may have been dissipated, scorched and charred very slightly when ignited, giving off the odor of burning wood. All the specimens of water examined were, in appearance, entirely clear; any suspended particles of organic matter must therefore have been very small and greatly diffused. Whether this organic matter is mainly from house drainage, mill refuse, or vegetable matter, might possibly be determined by microscopic examination of structure. Its nature is of more importance as a sanitary question than its quantity. Germs of disease may exist in cases where the sum total of organic matter is so insignificant as to be barely recognized by chemical tests. Former analyses, previously referred to, show that the Schuylkill water at Belmont contains more diffused sewage than at Fairmount; much of it, doubtless, subsiding in the stretch of river between these places.

When the water in question, at first absolutely neutral, was somewhat reduced in bulk by boiling, it became alkaline. Both it and the steam given off from it, as well as an aqueous solution from digesting powdered Belmont boiler scale in water, quickly blued red litmus paper. This at first induced a suspicion of ammonia, derived from the reaction of organic and inorganic matter, and a considerable amount of water was boiled down with sulphuric acid, to retain any ammonia as sulphate. The result was heated with potassa, but no odor of ammonia was perceptible. It may be a question, therefore, whether the alkaline reaction was effected by an organic or an inorganic alkali, either developed or concentrated by boiling down the water. Possibly a basic salt of magnesia, a mixture of magnesia and chloride of magnesium, obtained by the partial decomposition of chloride of magnesium, may have been the cause. Much factory refuse is alkaline. Films of sand and earth, chiefly clay, colored by a large proportion of peroxide of iron, appeared, and coated the sides of flasks in which the water was about half boiled down. These films restored the blue color of reddened litmus paper. This tendency of the water to become alkaline when boiled down, does not appear to affect health injuriously. Cautious water-drinkers can neutralize the faint excess of alkali by adding an equally minute trace of sulphuric acid, or, better still, by the more popular admixture of lemon-juice and sugar.

The Schuylkill water has at times presented odd phases, not all of which have been agreeable. In the summer of 1872 it appeared of a dark brown mud color, and remained so for some time. The coloring matter continued suspended and diffused, very little subsiding. In the water department report for 1874, Prof. Cresson describes a sedimentary clay found by him in water from Fairmount forebay, February, 1872. The particles were very minute, gave a peculiar taste to the water, remained in suspension several weeks, and were not removed by ordinary filters. He traces this sediment to a clay belt crossing the river above Reading, from which it is brought down when the river margin is covered with melting snow or ice.

Schuylkill water, even when comparatively clear, has a perceptible argillaceous smell and taste, probably owing to inappreciably small and diffused clay particles.

When uncontaminated by foreign admixtures the Schuylkill water is better suited for drinking purposes than that supplied to most other cities. Its reputation, in this respect, is world-wide.

THE "REVIEW" AS AN ADVERTISING MEDIUM.

The editors of the REVIEW do not purpose developing their journal as an advertising medium solely. On the contrary, it is designed to follow out the original policy of deriving the chief income of the paper from subscriptions; a policy that has heretofore proved satisfactory and remunerative. The editors have the gratification of having thus far more than fulfilled every promise made to subscribers and advertisers—in having given a larger circulation and a much larger and better paper.

Concerning our circulation—we do not claim, nor do we issue, as large an edition as some few of our contemporaries. We have an excellent and well-chosen *bona fide* circulation, largely among *the heads of heavy manufacturing firms;* we take great pride in the vigor with which our subscription department is being pushed; and with the branch offices recently opened in the various principal American and foreign cities, and constituting a rapidly increasing list, we have every reason to hope for very flattering results.

Our relations with our contemporaries are of the most friendly and pleasant character; perhaps not a little owing to the scrupulous care with which we credit to its proper source, each article or item copied or abridged from our neighbors.

The merit of the articles appearing in the REVIEW is best evidenced by their frequent reproduction in other journals here and abroad.

The very pleasant general appreciation of our paper, shown by our rapidly increasing subscription list, emboldens us to consider seriously the question of a further and early enlargement.

We can, then, confidently present the claims of the REVIEW as a valuable advertising medium; and will, when desired, permit our advertisers to inspect at any time our subscription and order books.

While for the general line of business we consider THE POLYTECHNIC REVIEW to be a good mode of reaching the eye of the consumer, there are certain businesses in which, from the special attention shown to them in the editorial department, and an inspection of the direction of our circulation, we can offer special inducements to advertisers. We claim special facilities for calling attention to the following articles of manufacture: Belting, Shafting and Pulleys; Blowers and Blowing Engines; Brick and Tile Machinery and Kilns; Bookbinding, Folding, and Pasting Machines; Builders' Materials; Cranes; Elevators; Engineering and Philosophical Instruments; Electromagnetic Engines; Fire Extinguishing Appliances of every description; Gauges; Gas Machines; Gas and Hot Air Engines; Gas and Water Pipes; Hydraulic Jacks, Punches, Portable Engines, etc.; Ice Machines and Tools; Illuminants and Lubricants; MACHINE TOOLS; PUMPS; RAILWAY SUPPLIES; Saws and Saw Mills; Turbine Wheels; Water Meters.

SAWS AND SAWING.—We propose publishing a number of the REVIEW especially devoted to the matter of wood-working machinery; and for which MR. JOSHUA ROSE will contribute a special illustrated article on SAWS AND SAWING.

SPECIAL TO INSURANCE MEN.

We desire to specially invite your attention to one feature which, at the request of gentlemenprominently connected with the fire insurance interests of this city, the editors intend to develop to an extent which other technical papers have not thus far striven to attain. We refer to the discussion of a large body of scientific questions involved in the subject of protection against fire. The discussion of these questions, and their treatment upon scientific grounds, cannot fail to result in great benefit to the Fire Insurance interest. The editors of the REVIEW are free from any entangling alliances, free from any bias, and may claim at least a fair scientific reputation; and whatever views they may advance upon this and kindred subjects, will not lie under the imputation of trying "to make the worse appear the better reason." We cannot here undertake to enumerate the subjects that will be treated in this connection—for their number is legion. A few that may give an idea of their nature are, for example:

(1.) The regular or stated description of the most approved forms of modern fire engines and fire extinguishing devices in general.

(2.) The construction of buildings, with especial reference to fire proof construction, and precaution against the spread of fires.

(3.) The protection of buildings, oil tanks, &c., against loss by lightning, etc.

(4.) The discussion of the properties—as regards safety or danger of the petroleum and vegetable and animal oils, with reference to their applications and uses in lamps, heating apparatus, as lubricants, and generally in mills, factories, &c.

(5.) The causes of mysterious fires—involving the treatment of the vexed subject of spontaneous combustion, explosion in flouring mills, &c.

(6.) Miscellaneous matters of interest, relating to this subject—discussions of possible improvements in various trades and businesses, with the object of lessening the liability to accident by fire—the heating of buildings and improvements thereon.

(7.) The subject of automatic fire-alarm systems of telegraphy—automatic fire-signals for domestic use, &c.

(8.) Protection of ships against fire, fire extinguishing appartus for ships, signals, &c.

(9.) Chemical questions, involving the treatment of the nature of various substances and compounds with reference to their possible influences in causing fires, &c.

In the above we have sought to give you a general idea of the drift of the proposed department of fire protection, which the REVIEW has recently commenced; and as before remarked, it is impossible to cover every point, for questions of vital importance to insurance men are arising almost every day, that require thorough examination by competent scientific men to settle properly and justly; new industries are constantly being created, new, or comparatively unknown substances are constantly introduced into the industrial arts, and insurance men are not often sufficiently well acquainted with their nature and properties to be able to judge correctly of the risk involved in taking insurances upon them—and frequently are heavy losers in consequence thereof.

In all such matters the editors of the REVIEW propose to keep their patrons well informed—and hold themselves prepared whenever a request is made to investigate any particular case, or to give advice upon any special subject, to examine into it, and tell what they know, or can find out, as soon as possible.

Of the illustrated articles on Steam Fire Engines, with which our series of articles on Fire Protection was commenced, and which appeared in the first number of the first volume, there have already appeared nine, in Nos. 1 to 5, inclusive, of Vol. i., and in Nos. 2 and 4 of Vol. ii. Fire Extinguishers have been treated of in No. 5 of Vol. i, and Nos. 3 and 12 of Vol. ii; and fire apparatus is constantly illustrated and described. An exhaustive discussion of the subject of Spontaneous Combustion has been carried through Nos. 5 of Vol. i, and 1, 5, 9, 10 and 13 of Vol. ii. Safety Matches were considered in Nos. 2 and 4 of the current volume; the non-combustible substance Asbestos, in its many uses as a fire-proof material, in Nos. 8 and 12 of the current volume; and the subject of Protection of Oil Tanks in Nos. 11 and 12.

There are yet to follow the continuation of the series on Fire Extinguishing Apparatus, and on Fire Proof Construction; articles on Oils and Explosives, and other topics of special interest, too numerous to specify.

SAFE OIL IN THE HOUSEHOLD LAMP.

It has been the constant effort of the writer for a number of years, to educate public opinion up to the point of properly realizing the enormous extent to which the adulteration of kerosene for the household lamp is carried; and to impress upon the public the conviction of the utter inadequacy of all the State enactments to prevent such adulteration, for although the provisions of these enactments are everything that could be desired *on paper*, their execution is unfortunately given over, in the majority of cases, to the charge of political favorites, whose duties begin and end with the drawing of their salaries and fees.

Considering the enormous sum-total of property annually destroyed by fires directly traceable to the indiscriminate use of adulterated burning oils, the writer has ventured the suggestion that the execution of the respective State inspection laws should be left, with reasonable restrictions, with the fire insurance interest, in whose hands, doubtless, their rigorous enforcement would speedily bring about a new order of things.

To aid in giving a clear notice of the dangers of using adulterated oils in the household, there are added hereto a few extracts from a report lately made by the writer on the subject of the light petroleum oils, considered as to their safety or danger in various domestic uses, and which was published at the instance of the National Board of Fire Underwriters for general distribution.

From the report in question, it appear that in regard to the inflammability of the petroleum products, two indications have been fixed, by which this quality may be conveniently estimated, and which at the same time afford the *only sure* indication of the safe or dangerous character of any of these products. These standards are called respectively the flashing and burning point. The first is the temperature at which the sample evolves an inflammable vapor; the second is that at which the oil itself ignites.

Subjected to the first test, the lighter portions of the oil will successively rise to the surface, will be there converted into vapor, which, when evolved in appreciable quantity, will ignite with a succession of flashes on the approach of a lighted body.

If the sample is mainly composed of a heavy oil (whose boiling point is therefore high), this succession of flashes will be the only phenomenon at first observed; for the heat evolved from the momentary ignition of the lighter vapors given off, will not be sufficient to start the ignition of the whole body of oil. The temperature at which this phenomenon is first observed, is called the flashing point.

If the heating of the sample is continued, a temperature will soon be reached at which the remaining heavy constituent begins to evolve its vapors, which, when sufficiently rapid, will, upon being ignited, inflame the body of the oil itself. This temperature is called the burning point. By this test alone is it possible to determine the character of these miscible oils; and so certain are the indications which it affords, that in the several legal enactments with which it has been found necessary to surround the traffic in these oils, it has been relied upon to correctly indicate their quality.

In a preceding illustration, it appeared that the addition of a small quantity of light oil to a heavy one acted in such a way as to noticeably lower its flashing point. This action grows more marked as the amount of the adulteration increases, and will, when a very moderate dilution has been reached, also seriously affect the burning point of the mixture, the lighter portion of the sample being readily inflamed from the flash of the greatly increased volume of vapor which it throws off.

Dr. D. B. White, President of the Board of Health of New Orleans, found, for example, in experimenting with an oil which flashed at 113° Fahr., that an addition of

One	per cent.	of naphtha	caused it to flash at	103°	Fahr.
Two	"	"	"	92°	"
Five	"	"	"	85°	"
Ten	"	"	"	59°	"
Twenty	"	"	"	40°	"

After the addition of twenty per cent., the oil burned at 50°.

It must be noticed that, though in general character, the petroleum compounds are almost identical, yet, when considered in relation to their adaptability as illuminants, a marked distinction can be made.

The heavy oil boils at an elevated temperature, and at the ordinary temperature throws off only an inappreciable quantity of vapor. A lighted match, approached to an open vessel containing it, will not ignite it, and if plunged into the oil, it will be extinguished. With the other members of the series, however, the boiling point is but a trifle removed from the ordinary temperature; and at the ordinary warmth of our dwellings, they are constantly throwing off volumes of vapor (the gasolene, of course, to a much greater extent than the naphtha). A lighted match approached to an open vessel of either of them, will ignite them at once, and at some distance from the surface of the material,

It appears, therefore, that the light oils, owing to their extreme volatility, cannot be handled with the same indifference as the heavy ones. An open vessel containing either of them, placed at some distance from the neighborhood of a flame, may, more likely than not, be the cause of sad mischief, and from a very simple cause. The vapor which it is constantly and imperceptibly giving off, flows from it in all directions, seeking the floor, in virtue of its superior density to the air—and once in contact with the flame—a flash—and the ignition darts, in an instant, back to its source.

Of the invidious, imperceptible nature of the dangers attendant upon their employment as illuminants, the public cannot be too clearly conscious or too forcibly warned. And under no circumstances is the employment of these incendiary materials so severely to be condemned as in the portable lamp so generally employed in the household. There are, it is true, circumstances under which they may be, with certain precautions, employed for other purposes than as lighting agents—and of these the writer will have occasion to speak further on—but, in the portable lamp, they may at any moment add another to the list of terrible accidents with which the public is already too familiar. Let the attention be but for a moment directed to the state of things involved. The body of the lamp is almost always of glass, and hence fragile. It is supposed to contain some of one of the lighter oils, the peculiar properties of which have just been alluded to. In the process of burning, the metallic attachments of the lamp will communicate sufficient heat to the body of the oil within, to fill the whole of the space above the oil with its vapor, So long, now, as the lamp remains unbroken, and its attachments without leakage, this circumstance is of little consequence, as, of itself, the confined vapor cannot be made to explode or ignite. But suppose the lamp, in this condition of things, to be shattered by a fall—a circumstance by no means infrequent—the consequence will inevitably be that the inflammable vapor in the neighborhood of the flame would at once ignite, and with it the whole body of oil in the lamp, to the imminent peril of person and property. Or suppose the equally probable circumstance, that the lamp, as before, should be refilled while burning, when the result might be, if possible, more disastrous than in the preceding case; for the volatile and inflammable vapors filling the upper portion of the lamp would inevitably, by their rapid diffusion into the air surrounding the flame, form an explosive mixture, from the effect of which the lamp and its burning contents would be scattered in all directions. Where the oil made use of is one of proper quality, neither of the accidents here hypothetically stated would be possible, since, in no case with a properly constructed lamp, could there be generated within the body of the lamp an amount of vapor sufficient to cause an explosion; nor could the oil itself be ignited at so moderate a temperature.

[*To be continued.*]

TO OUR SUBSCRIBERS.—We are desirous of increasing the amount of reading matter in the "REVIEW" about one-fourth, without extra charge to you. If each of you will secure an additional subscriber *conditioned* on an increase of *one-eighth* in our reading matter, the change will be made. We think this plan better than giving chromos.

THE TEMPERATURE OF THE SUN.—Mr. Hugo Bilgram has kindly furnished for this journal, at our request, an abstract of his highly interesting paper, on the above-named subject, read before the Franklin Institute.

ANNUAL REPORT OF THE HARTFORD STEAM-BOILER INSPECTION AND INSURANCE COMPANY, 1875.

COMPLETING THE FIRST DECADE.

III.

There have been a great many explosions of vertical tubular boilers which, in the main, have occurred from poor management or carelessness. When a man wants but little power he usually selects the vertical form of boiler, and inasmuch as it is small, he thinks, or appears to think, a man of small capacity can run it, or that an employee who has other duties to attend to, can attend to the boiler as well. Under these circumstances the boiler will not receive as good care as it would otherwise. It will not be blown out and cleaned as often. The sediment will be very likely to collect in the water-legs and on the crown sheet. It doubtless seems an unnecessary expense to a machinist, whose shop is all in one room, and whose boiler and engine are in one corner, to employ a man to attend exclusively to them, and it is. But it is important that some person be responsible for the condition of the boiler, and that he sees to its cleaning and care.

Figure 17 is of a boiler that exploded in Danbury, Conn., January 17, 1875. The boiler is of the vertical type, 8 feet 6 inches long, 48 inches in diameter, having 79 tubes. The iron of the shell was 5-16ths of an inch thick. The boiler was well supplied with the necessary attachments. The mill to which this boiler supplied steam was shut down on Saturday night, and the fires were banked. It was in mid winter, it must be be remembered. The boiler was visited but once on Sunday, and the water was ascertained to be very low. The engineer, however, declined to start the pumps, saying that to do so he must start the whole mill, and that it was not necessary at that time. He preferred to wait until Monday morning. At about 10½, P. M., Sunday night, the explosion occurred. The mill was subsequently burned. The boiler was thrown some 230 feet, passing over a dwelling, on its flight, in which seven persons were sleeping.

A vertical tubular boiler exploded at Woburn, Mass., March 15, 1875. It was 7 feet high and 30 inches in diameter, shell $\frac{5}{16}$ thick, heads $\frac{3}{8}$. It had 35 tubes. The safety-valve, it was ascertained, was overloaded, and the steam gauge showed that it had indicated, to its utmost limit, nearly 300 pounds. The boiler appeared to be well constructed, though there was no staying in the fire-box. Boilers of this diameter are frequently without stays. Figure 18 illustrates the appearance of the boiler after the explosion.

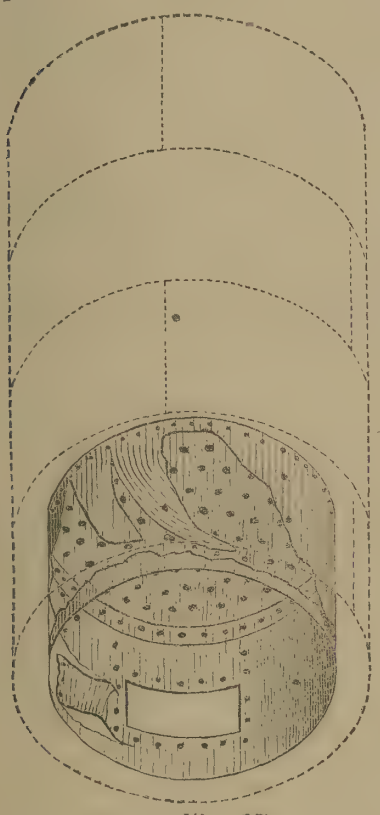


Fig. 17.

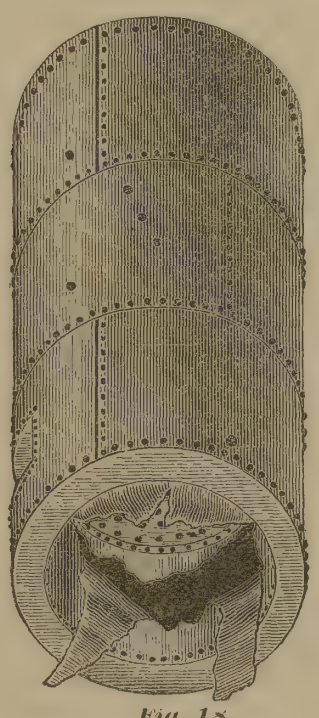


Fig. 18.

In July, 1875, an upright tubular boiler exploded in Tiverton, R. I. It was 12 feet high, 48 inches in diameter; shell $\frac{5}{16}$, heads $\frac{3}{8}$, with 100 tubes two inches in diameter. The safety-valve was two inches in diameter, but the escape pipe therefrom was only one inch in diameter. The fire-box had no staying. The boiler was run up to its full capacity. The explosion was, without doubt, occasioned by want of staying in the fire-box, and insufficiency of safety-valve relief. We could discover no indications of burned plates. Figure 19 shows the point of fracture.

An upright tubular boiler exploded at Paterson, N. J., on the 12th of Nov., 1875.

Figure 20 shows the boiler as it was constructed; also the fractured fire-box, and lower tube sheet, as they appeared after the explosion.

A careful examination of this case showed the boiler to have been badly overheated. It was carelessly attended. The gauge-cocks were out of order and seldom used. The feed-pump was in bad condition. The force of the explosion threw the shell of the boiler some 300 feet high, and it fell nearly 1,000 feet away.

The furnace was blown clean out of the shell, drawing out the heads of the screw stay-bolts, tearing the sheet along the water-leg, and detaching the tubes from the tube sheet, as shown in the figure. The defects enumerated here would have been detected by careful inspection.

A large drop-flue boiler exploded in Lee, Mass., June 8, 1875. From the position of the boiler in the yard, after the explosion, we were led to believe that it gave way on the bottom, a little to the right of the centre, and this theory was fully confirmed

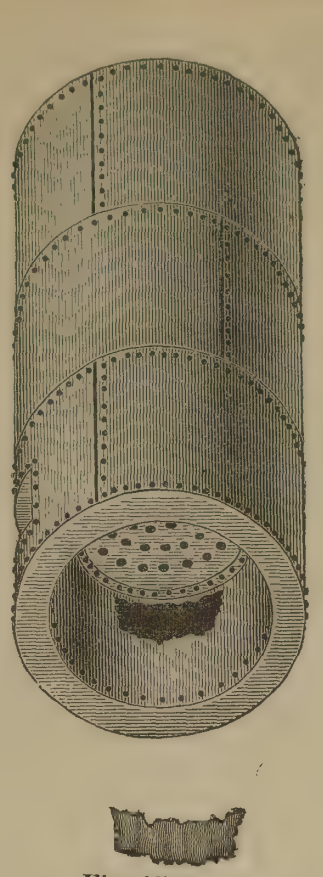


Fig. 19.

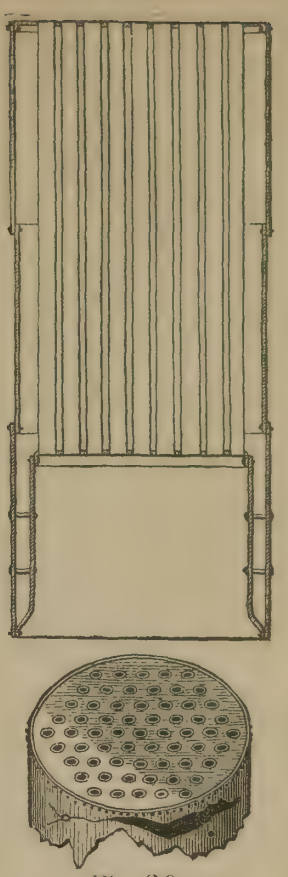


Fig. 20.

when the fragments were all collected. It was ascertained that the boiler had been leaking on a longitudinal seam, just back of the drop connection. This leakage caused corrosion on the longitudinal seam, and on the girth seam up from the longitudinal, some eight or ten inches. The plate had been eaten through in spots, and was very thin all along the seam. The break commenced at this seam, following up the girth seam as far as the corrosion extended, and then ran along the line of rivets clean around the boiler. This ring of plates was torn out with the dome and thrown a distance of several hundred feet. Other portions of the boiler were scattered about in various directions. The boiler was reported to be thirteen years old, and had been

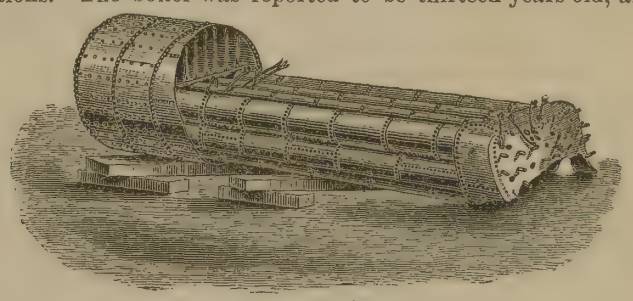


Fig. 21

used constantly, running most of the time night and day. The safety-valve was weighted at eighty pounds. The working pressure was seventy-five pounds. There were no indications of low water. The boiler was run at too high pressure for one of its type, even if the plates had been sound. The defects would have been easily discovered by inspection, and the calamity probably averted.

Figure 21 shows the boiler as it was after the explosion.

(*To be continued.*)

FIRE PROTECTION.

THE WRONG END OF THE STRING.

Much ingenuity is directed, and time and money spent, in devising and applying means of fire *extinguishment*. Costly establishments are maintained in readiness to dash out instantly at any time, to put out a blaze that would else become a conflagration; lives are lost in the service of these Fire Departments; and their effect on the political and general *morale* of a city is generally unhealthful in the extreme. Owners supply their buildings with pumps, pipes, hose, extinguishers, and all the modern appliances for putting out fire, and pay a heavy insurance tax. All these expensive precautions are, under existing circumstances, highly praiseworthy and are generally effectual. Yet at times they are impotent for good; and the point that we ought to see, after the great lessons of Portland, Boston, and Chicago, is that *we are pulling at the wrong end of the string.* We are seeking cures rather than preventives. It is much more sensible to keep banana-skins off the pavement, than to endow corner-stands for setting broken limbs; to enforce sanitary precautions, than to make appropriations for typhoid hospitals.

If we were to set about to find a perfect means of fire proof construction, and were to encourage and enforce the adoption of such a system, we would be vastly better off, and would have a sense of security that is entirely wanting to us now. Houses have no business to burn. If they are built right, they will not and cannot burn. They *can* be built so; and about one in sixty thousand *is* thus built. Let us have the good-sense to consider this, and to get at the root of the matter by studying and practising Fire-Proof Construction. G.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

Street Railroad Locomotives.—Office of Porter, Bell & Co., Builders of Light Locomotives, Pittsburgh, Pa., Sept. 26, 1876.

To the Editor of the Railroad Gazette: We notice in your issue of the 22d, a very clear statement in the editorial columns of the advantage of the use of steam on street railroads. If our experience in this direction is of any use to you, you are welcome to it.

We have built a number of our light locomotives for this service with very satisfactory results. The New Orleans City Railroad is using our 8×16 engines with four 40-inch drivers and two-wheel pony truck, rigid wheel base 5 ft. 9 in., and weight about 10 tons. The same road is using our 7×12 in. engines four 30-inch drivers and no truck; wheel base 4 ft. 8 in.; weight about 7 tons. These engines are inclosed in imitation of street cars, and give no trouble from noise or smoke, and the larger size is capable of a speed of 30 mlles per hour, and the smaller of 20 miles with a light load; the usual speed is about 10 miles. These engines haul from 6 to ten crowded street cars, and on this road, which is almost a dead level, could haul twice as many. We have also built for street railroads where the grades are as steep as 250 ft. per mile, and find that locomotives are just as preferable to horses on steep grades as on level. The smallest size we have built is 6×10 in. cylinders, weight about 5 tons. We entirely agree with you that for this service a combined car and engine is not so good as a separate locomotive, and also believe that such a locomotive, however small, should be built as thoroughly as a large road engine, and even with more care, as the service is usually very hard, on account of sharp curves, steep grades, rough track, and mud and dust. PORTER, BELL & Co.

A new Pavement, composed of 85 per cent. fine ground granite, and 15 per cent. of bitumen, has been laid in Newgate St., London. It is stated to be free from slipperiness and unaffected by the atmosphere. It is laid in a heated, semi-fluid condition, two inches thick, upon a foundation of Portland concrete nine inches thick. [Abs. from *Sci. Am.*, xxxv, 223.]

An Improved Link Block for locomotives is composed of two longitudinal parts, with suitable wedge between to set them out and take up wear. It is claimed to tend to the preservation of the link, and smooth running of the engine.

—The work on the Hoosac tunnel was first earnestly commenced in 1855, and is said to have cost, up to January 1, 1876, about eleven and a half millions of dollars, to which may be added nearly four millions of dollars for interest, making a grand total of over fifteen millions of dollars.

Book-binders' Sewing Machine.—The Singer Manufacturing Co. has produced a machine for stitching book sheets. The fastening should be elastic and strong.

MINING, METALLURGY AND MINERALOGY.

A Ridge of Gold Quartz thirty miles long is reported to have been recently discovered in New South Wales. It is declared to contain an enormous percentage of gold.

The Smelting Works of Utah Territory have produced 26,000,000 pounds of base and bullion since the first of last February.

The Chattanooga Times is authority for the statement that there are at the present time more iron furnaces in blast in the South in proportion to the number of existing furnaces than in the North.

Abandonment of the Great Zinc Mine at Friedensville, Penn.—Later advices would appear to confirm the item in the last issue of the *Review*, alluding to the probable early abandonment of the zinc mines at Friedensville. It is now affirmed that the Bethlehem Zinc Company, having contracted with the New Jersey Zinc Company, for the supply for five years of 12,000 tons a year of zinc ore from the Sterling mines in New Jersey, has decided to abandon the further working of their famous mine near Bethlehem, Penna., and to allow it to fill up with water. The Friedensville ore deposit has been worked for years in the face of great natural hindrances on account of water, and some years ago was provided with the largest pumping engine in the country, which, of late, has been pumping from the mine about 30,000,000 gals. of water per day. The increasing cost of pumping, to prevent the flooding of the mine, which has of late exceeded $4 per ton on all ore raised, is the cause of the proposed abandonment of this famous mine. The ore deposit at the Sterling mines, from which the Bethlehem Zinc Company propose in future to obtain their supply, is enormous, and so easily worked that its cost delivered in the cars is said not to exceed 75 cents per ton. [*Vide, Eng. and Min. Jour.* xxii, 216].

CHEMISTRY, PHYSICS AND TECHNOLOGY.

To Freeze Mercury. (M. Weitz). If to a quantity of snow, as spongy as possible, there is added an equal weight of commercial hydrochloric acid (sp. gr. 1.18) having a temperature a little below the freezing point of water (—1° C.), there results from the mixture in less than one minute a complete solution having a temperature of —37.5° C. (—35.5° Fahr). This extreme degree of coldness M. Weitz has found, may be preserved for a long time by surrounding the vessel with a non-conducting substance. By making use of a similar mixture, where the acid had previously been cooled down to —18°C., the same investigator found that mercury could be frozen with it in a short time. M. Regnault has employed a similar freezing mixture for the same purpose. [Abr. from *Boston Jour. of Chemistry* xi, 39].

Solution of Salicylic Acid. The following addition to the number of solvents for salicylic acid may be found useful. To obtain a strong solution of the acid, it is recommended to use the acetate of lime. If this is not at hand, the acetate of potassa, or any of the acetates of the alkalies or alkaline earths will answer the same purpose. Any of these solutions, after standing, develop free acetic acid, which is not injurious, but on the contrary increases the antiseptic properties of the salicylic acid [Abr. from *Boston Jour. of Chem.* xi, 48].

New Salts of Bismuth. Mr. Carnot has made the interesting observation that the double hyposulphites of bismuth with alkalies are distinguished from all the salts of this metal with mineral acids, by complete solubility in water. He prepares, for example, the double salt with soda, by adding to a slightly acid solution of chloride of bismuth, a concentrated solution of hyposulphite of soda. This reaction produces a yellowish coloration, but the liquid remains perfectly clear (if enough hyposulphite has been added) and the addition of either water or alcohol fails to produce a precipitate. This compound is therefore distinguished from ordinary salts of bismuth by its solubility in water, and from hyposulphites by its solubility in alcohol.

Mr. Carnot has also observed that the addition of chloride of potassium added to the clear alcoholic solution of this salt, produces an immediate precipitate of a siskin-yellow color. This precipitate is not produced by the chlorides of sodium, lithium, ammonium, calcium, magnesium, aluminium, iron, manganese, etc., in a word, by any of the metals (besides potassium) that are not precipitated by sulphuretted hydrogen. The reaction therefrom appears to be characteristic of the salts of potash. The author therefore proposes the hyposulphite of bismuth and sodium as a reagent for potash salts, and promises shortly to indicate the manner in which the reaction just described may be practically utilized for the separation and determination of potash. [Abridged from *Chem. News*, xxxiv, 119]

A Remarkable Deposit of Tripolite (infusorial earth) is affirmed by Dr. T. L. Phipson to exist on the Island of Barbadoes. It is mixed with a little carbonate of lime, and under the microscope it is found to be exceedingly rich in remains of diatomaceæ, the forms of which are very well preserved. The analysis given indicates the deposit to be one of unusual purity, showing as much as 71·5 per cent of silica soluble in caustic alkali. It is an excellent polishing material, and has been made use of as a non-conducting covering for steam boilers. [Abr. from *Chem. News*, xxxiv, 108.]

Petroleum as a Lightning Conductor.—The destruction of oil by lightning this year has been remarkable, amounting to 242,412 bbl., from January 1st to July 31st of this year, or rather from April to August; there were no fires from this cause in January, February, or March, two in April, none in May, four in June, and five in July. It is scarcely necessary to inform our readers that the oil destroyed is in closed-top iron tanks, and the lightning striking these, explodes the gas that collects in the space above the oil, scatters the oil, and sets it on fire, and in this way often communicates to other tanks in the immediate vicinity. The theory most commonly received in the oil regions of the cause of such frequent lightning "strikes" is that the gas, which, it is well known, is continually escaping from the oil in these tanks, rises to some distance above the tanks, acts as a conductor, attracts the lightning and the damage is done One peculiar feature in the history of these accidents is, so far as we have been able to learn, no iron-top tank has been struck, but in every case wooden-top ones. We have made special inquiries on this point with the uniform result given. So far, attempts to protect tanks with lightning rods have been failures; at Dilks Station a number of rods, supposed to be ample protection, were placed about the tanks, but they were no protection against this summer's bolts. It may be interesting to those not acquainted with the oil business to state that, in case of losses occurring in this way, all the oil in the pipe line to which the tanks belong is assessed pro rata for the loss; that is, the law of "general average," so well known in Marine Law, is applied in this case.—*Stowell's Petroleum Reporter.*

NOTE.—The theory that would explain the frequency of lightning strokes by assuming that an ascending vapor column rising from the reservoir to a considerable height, acts as a conductor, etc., has no foundation in fact. The vapors of petroleum are heavier, not lighter than air, and will not, therefore, "rise to some distance above the tanks; "and even supposing that it did, we are not aware that it would afford a better path for the lightning than the surrounding air. We have already indicated the cause of the dangers to which oil tanks are exposed by lightning, and the reader will find in our Nos. 11 and 12 a full treatment of the subject. Such speculations as the one here criticised will not bear examination.

Artificial Indigo. Some years ago Engels and Emmerling professed to have discovered a method for the artificial production of indigo, and a small vat is said to have been set with the product obtained. Wichelhaus, however, having tried the process given by the discoverers obtained a sublimate, not however of indigo, but of zinc, derived from the powder of zinc employed in the reaction. [*Man. Rev. and Ind. Record*, ix, No. 2].

MISCELLANEOUS.

An International Exhibttion will be held in Cape Town, in 1877, by consent of the Colonial authorities. The proposed exhibition will include manufactures of all kinds. The date of opening is fixed for February 15th, and everything intended for exhibition must be shipped from London not later than the first week in December, 1876. Intending exhibitors are invited to communicate with Mr. Edmund Johnson, Commissioner, at the European Central Office of the Exhibition, 3 Castle Street, Holborn, London.

The Pacific Mail Steamship, City of Pekin, is reported to have made the remarkable passage from Yokohama to San Francisco, a distance of about 5,000 miles, in 15 days, arriving at the latter port on Sept. 1st. This is a daily average of 337 miles, or 14 knots per hour.

The latest phase of the Cremation question is the proposition of an Englishman, who proposes, says the *American Manufacturer*, to utilize the crater of Vesuvius by using it as a receptacle for the bodies of the dead. He proposes also the formation of a company to run funeral trains from different parts of Europe to the volcano.

—American "Russia Leather," as now made, is superior to original and genuine. Minister Jewell, while in Russia, discovered the secret of the "aroma" to be *birch tar*, and sent a quantity to this country, where it is now used largely, although, perhaps, in too great proportions. [*Abs. from Shoe & L. Rep.*, xxii, 369.]

Experimentation on the Painless Extinction of Animal Life.—By Benjamin W. Richardson. The latest experimental researches which I have conducted on lower living animals have had for their object the discovery of a ready, cheap, and innocuous method for killing without pain those animals which are destined, as yet, for the food of man. If the labor of the physiologist be allowed to progress, the day will soon arrive when the slaughter of animals for food will become unnecessary, since he will be able to so transmute the vegetable world as to produce the most perfect and delicious foods for all purposes of life without calling upon the lower animal world to perform the intermediate chemical changes. But until this time arrives animals will have to be slaughtered, and my research has been directed to make a process, which at present is barbarous and painful, painless in the most perfect degree. For this purpose the various modes of rapid destruction of life—by powerful electrical discharges, by rapid division of the medulla oblongata, and by the inhalation of various narcotic vapors, have been carried out. The experiments, which have been exceedingly numerous, have led me to the conclusion that the most perfect of the painless methods of killing is by the inhalation of carbonic oxide gas. So rapid and complete is the action of this gas, that I may say physiological sience has done her part, as far as need be done, for making the painless killing of every animal a certain and ready accomplishment, an accomplishment also so simple that the animal going to its fate has merely to be passed through the lethal chamber in order to be brought in senseless sleep into the hands of the slaughterer. The application of teaching and the putting into practice this humane process lies now with the world

outside science; but to insure its accceptance all the force of selfishness, of prejudice, and of practical apathy for the sufferings of the animal creation, have to be overcome. There is a great deal of talk and a great deal of sentiment abroad on the question of the sufferings of the lower animal kingdom, but when an attempt is made to relieve those sufferings by the inventions of methods for the operating, surgically, without the infliction of pain, or for painless killing, the true vital sympathy which one would expect in support of such practical and humane efforts, until they are made universal, can scarcely be said to be found at all. With the exception of a few, not a dozen altogether, of really humane ladies and gentlemen, I have found no one, out of the ranks of science, in the least interested in the saving of sufferings to which I am now directing attention. The man of science stands and wonders at the strangeness of the psychological problem before him, and, in spite of himself, is forced to the conclusion that, practically, the noise that is made at him in the name of humanity is, after all, sounding brass and tinkling cymbal. [*Nature* xiv, 372.]

India Rubber. While nations have been agitating themselves with affairs in the East, and fears of change, and other like dangerous and distracting matters, a wiser man has been devoting himself to the study of the great india-rubber question in the forests of Darien. The world could get on very well without Eastern questions, but could not manage at all without india-rubber, and there has been reason to believe that the native way of supplying the commodity is wasteful, and would in the end be destructive. Indeed, our explorer has found it the custom to cut down big trees, varying from 150 to 200 feet in height, for the sake of an amount of rubber varying from 100 to 150 pounds. He has also found what are the climatic conditions best suited for the growth of the tree; and to these and similar explorations, the Kew authorities have just given a practical turn, for a shipment of thirty-eight cases of Brazilian india-rubber plants, containing over 1,900 plants, has recently been dispatched from Kew to Ceylon, and, it is worth mention, within the remarkably short space of two months from the time of the seeds being sown. This tree yields the finest kind of caoutchouc, or "india-rubber," with which we are acquainted, imported from Para, in Brazil. The Royal Gardens have for some time past been occupied in its cultivation for introduction to those countries where it may be expected to become a rubber-producing tree. In June of this year 70,000 seeds were received, of which only about 3¾ per cent. were alive. In consequence of their retaining vitality but for a very short period, they were all sown the day after arrival, and, though not contained in pans, covered a space of over 300 square feet, closely packed together. A number began to grow almost immediately, and many within a few days reached a height of 18 inches. So quickly do they grow that the cases had to be made from special measurement, allowing for growth during transit. Each case contains, as a rule, fifty plants. Besides these to Ceylon, other cases have been sent to Singapore and Burmah, and still others are in hand for various destinations. Altogether it is likely that about 2,600 plants will be distributed from this batch of seeds. This is good work, and we may reasonably hope for it the same success that has been attained in the case of our cinchona plantations. [London *Evening Standard*].

The Eucalyptus Globulus.—The Italian Government, persuaded by the success of the Trappist brotherhood of *San Paolo fuori le mura di Roma*, that the Eucalyptus Globulus has a beneficial influence in malarious districts, has presented to the land-holders of Italy, large supplies of slips of the tree for the purpose of forming plantations where its virtues seem required. The Government also intends to grow the Eucalyptus along the boulevards of the large cities, and even along the various lines of railway throughout the Kingdom. Landholders themselves are following the initiative of the Government, and in a few years Italy expects to drive malaria effectually from her boarders. [*Druggists' Advertiser.*]

—The machinery for the manufacture of wood paper hangings has been so perfected that an inch of white maple or other fine grained wood can be slit so as to furnish two hundred thin leaves, having the surface and grain of the wood. These leaves are laid upon a paper backing, and, thus constituted, may be fastened to the wall the same as common wall paper. A room thus furnished presents the appearance of a paneled apartment, since all the surface visible is that of the actual wood; with smoothed and polished woods of a coarser or more open grain, the number of leaves or veneers to the inch is one hundred and twenty-five. [*N. L. Lumberman.* vii, 88.]

Our Internal Commerce.—The last number of Poor's Railroad Manual, as good authority as we have, gives the tonnage of all the railroads in the United States the past year as 200,000,000 tons, having increased forty-fold in the past twenty-five years. At $50 per ton the value would be $10,000,000,000. The canals of the country transported less not than 10,000,000 tons, worth $500,000,000, of which the Erie took one-half. The tonnage of vessels employed in the domestic trade of the United States is 4,000,000 tons, Estimating four voyages a year and allowing for light freights, the tonnage moved in this way may be placed at 15,000,000 tons per annum, worth $750,000,000. This gives a grand total of $11,250,000,000 per annum as the volume of the internal commerce of the United States. This is ten times as great as our imports and exports combined. [*Boston Commercial Bulletin*]

—The French minister of public works has given orders for the construction of the great refracting telescope, 17 metres long (53 feet), to cost 210,000 francs. Two years will be required for the work. [*Eng. News* iii, 307].

—An exchange says: The Boston and Albany railroad recently took off a set of steel car wheels that had run 523,000 miles—a greater distance than was ever run by any car wheels before in this or any other country. The average running distance of a common chilled iron car wheel is only 30,200 miles. These steel wheels, which are rapidly coming into favor on the leading roads, are warranted for 300,000 miles, after which they can be turned down and used again.

IMPORTANT PAPERS, too long to reproduce in our columns.

The Justifiable Expenditure on Improvement in the Alignment of Railways. By A. M. Wellington, C. E. In *R. R. Gazette*, viii, 403, *et, seq.*

CENTENNIAL NOTES.

Hall's Universal Fencing Machine, in Agricultural Hall, is one of great utility, It bores all the holes in a post at once, saws off the ends of posts and rails by actual measurement, and turns handsome tenons and shoulders on the ends of the rails.

Much timber can be made into valuable fence, that would be otherwise wasted, and as the posts stand on the ground, the labor of digging holes, and the decaying of the inserted ends, are saved.

The fence is strong and durable, and all persons having much fence to make will do well to examine this machine and its work. We will give a detailed description of the machine and product. H. S. S.

The Lärgest Belt in the World. Messrs. J. B. Hoyt & Co., of New York, have just placed on exhibition in Machinery Hall, a double belt of oak-tanned leather, 186½ feet long, 60 inches wide, and weighing 2212 pounds. This is believed to be capable of transmitting 600 H. P.; and is made for the "Augustine" mill of Jessup & Moore, paper manufacturers, Wilmington, Del.

Newspapers at the Centennial. The special correspondent of the London *Times* says it would be difficult to find an apter illustration of the big way in which the Americans do things than that furnished by the "Centennial Newspaper Building," in the Exhibition grounds. Here you may see any one, or, if you like, all of the 8,129 newspapers published regularly in the United States, and see them, one and all, for nothing! You are not only permitted as a favor to see them, but invited, nay, pressed, to confer the favor of entering the building and calling for what paper you like. It is about as cool and agreeable a place—quite apart from its literary attractions—as a visitor to the Exhibition could wish to be offered a chair in. He may at first wonder how, among 8,000 papers, among them such mighty sheets as the New York *Herald*, he is to get at the small, loved print of his home, thousands of miles away, it may be, over the Rocky Mountains. But the management is so simple that, by consulting the catalogue, or even without the aid of the catalogue, any one can at once find whatever paper he wants. They are pigeon-holed on shelves in the alphabetical order of their States or Territories and their towns, the names of which are clearly labelled on the shelves. The proprietors of the Centennial Newspaper Building are advertising agents, the largest in all America—Messrs. G. P. Rowell & Co., of New York. Their enterprise will cost altogether about $20,000, or £4,000, including the building and the expenses of "running" it for six months.

The 8,000 and odd American newspapers are declared by the same authority to exceed "the combined issues of all the other nations of the earth." One is somewhat surprised to find that of this number no less than 6,235, or more than three-fourths, are weekly.

The State of New York naturally supplies the largest number, 1,818; in the city alone there are considerably over 400. Next comes Pennsylvania with 738, Philadelphia contributing over 160. Then come Ohio, Iowa, Missouri, and Indiana, all outstripping, one is surprised to find, that model state and centre of enlightenment, Massachusetts, though she issues nearly 350. It is worthy of remark that the West, young and raw as it is, seems more go-ahead and enterprising in journalism than the refined and venerable East. California already ranks fourth in the number of its dailies. For five years six new journals, on an average, have been started in America every day; but as old ones die out, the actual increase during that time has not been much over 2,000. Some of the names of American newspapers might to an Englishman seem enough to strangle them in the birth. Such are the *Union Spy*, the *Jolly Giant, Aurora Brazileira, Broad Axe of Freedom, Unterrified Democrat, Painted Post Times, Roman Citizen,* and—Greek shades forgive for ever chronicling such an outrage—*Homer's Iliad* side by side too with *Horseheads Journal.* After this it is somewhat of a relief to be assured that a "high average (of newspapers) is always found in company with a high standard of education and good order.

—In addition to the more substantial exhibit of the Page Belting Company, there is an immense ox-hide, tanned and finished for belt leather, that weighs now, in its finished condition, 93½ pounds. This is the heaviest ox-hide ever exhibited.

SCHOU'S TIRE UPSETTER.

Mr. Matthias Schou, of Freehold, N. J., exhibits a very powerful and convenient tire-upsetter, shown in the accompanying cut.

There is a standard to which is bolted a cast-iron frame, formed with which is the anvil, having a somewhat concave face. Wrought-iron straps, bolted to the frame at its lower

end, form bearings for the fulcrum pin of a lever, which carries the moving jaw (cast with it in one piece.) This lever has a brace and web for strength. A spring is interposed between the frame and lever, to keep the jaw extended. The upper end of the lever has a rounded projecting lip, over which fits a hook-shaped lip on the operating lever. This lever is hung on a pivot secured on the outer ends of two bars which are bolted loosely at their outer ends, to the frame, so that they may rise and fall with the operating lever.

The strains are very judiciously distributed. The main lever has no forced fulcrum, but from near its centre a connecting rod extends to a handle on the moving jaw. Each jaw can be independently operated, so that articles of different widths can be as securely clamped as those of uniform width. It will, of course, be understood that when one jaw has taken hold of the article to be upset, the other jaw will be also brought to bear upon it with the srme amount of friction, but not necessarily in the same line.

In upsetting thin articles, as steel tires, it becomes necessary to use means for preventing them from springing up. For this purpose there is employed a spring-lever, which has a curved bearing-face for contact with the tire, and is held in a

recess in the frame by means of a pintle and pin, the pin being removable, so that the lever may be readily detached when necessary. The upper end of the spring-lever rests in an opening in a projection of the anvil, and against this projection a spring on an arm of the lever rests, so as to keep the lever raised. The spring-lever may be operated by a rod and treadle ; or a bar or hand-lever may be employed by resting its point in a hole in the frame, and inserting a hook in the eye in this lever's end, and properly applying the necessary force.

In order to prevent the heated metal, when being upset, from extending between the jaw and anvil—an evil of frequent occurrence—there is a plate secured by a pin in a recess in the anvil, and working in a groove in the moving jaw, whereby the space between the jaw and anvil is constantly bridged.

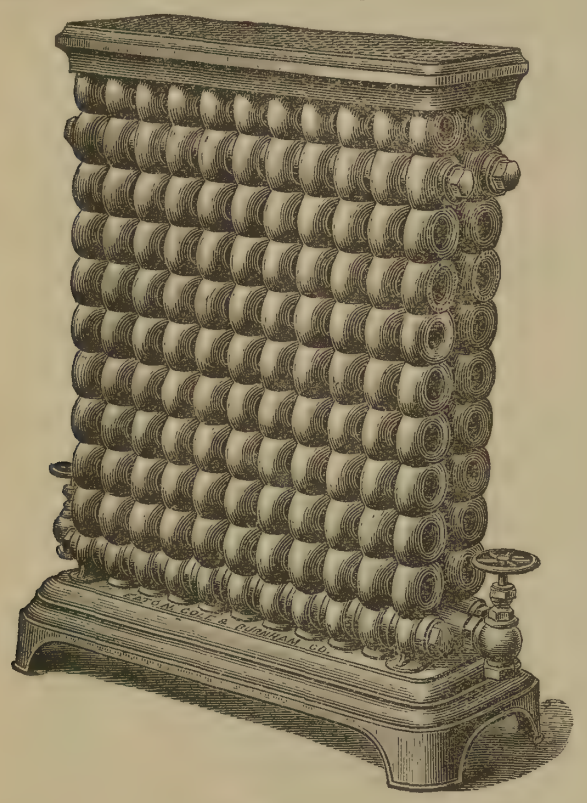
To prevent lateral spreading of the article being upset, there is a plate set in the anvil by pins and easily removable. This plate is curved to conform to the anvil.

If a straight article is to be operated upon, the bed of the anvil may be leveled by inserting in pin-holes therein a flat-faced plate, the bottom of which is curved to fit the anvil.

Snow's Cast-Iron Radiators.

(Made by the Eaton, Cole & Burnham Co., N. Y.)

These radiators are made of sections of hollow rings disposed one upon the other on the same plane, forming a connected series of intercommunicating ring passages. The steam is taken from the bottom through the first section only,



DOUBLE SECTION.

to the top of the radiator, then along the top to every other section. The sections are connected by a peculiar process of nippling. There should result from this mode of construction, a large radiating surface in a compact space ; strength, and economy of metal, and good circulation of steam. By admitting the steam at the top only, annoyance from water of condensation should be reduced to a minimum.

Westcott's Combination Lathe Chucks.

The improvement consists in not only making the jaws reversible, by which arrangement the small sized chucks can be used with facility in holding screws, pipes and drills, but also in making them to act independently of each other when required, as well as to act concentrically and simultaneously. This chuck is therefore enabled to seize and hold firmly round, oval, square, oblong or eccentric shapes, as well as to hold work in accurate position.

Fig. 1 is a front view of the chuck with one of the jaws reversed.

Fig. 1

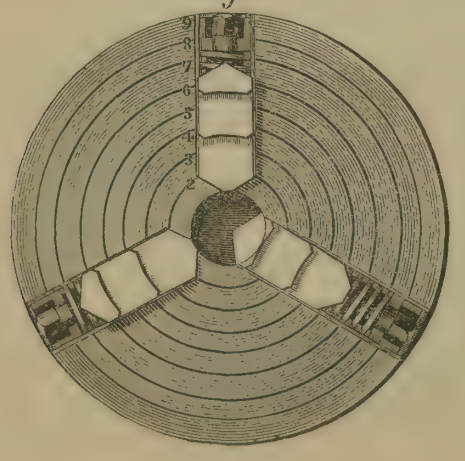


Fig. 2

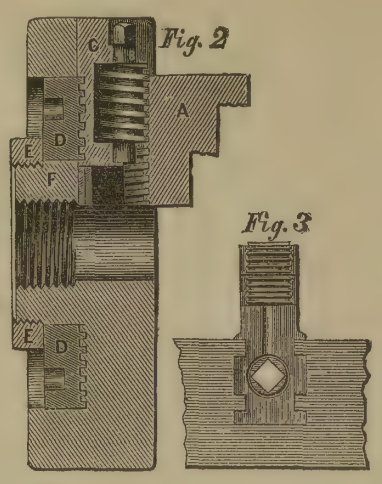


Fig. 3

Fig. 2 is a vertical section, showing the manner in which the ring, D, engages in box, C ; also showing the position of the screw, B.

Fig. 3 is a section of the chuck showing the end of the screw and box, C ; also the durable manner in which all the parts are secured to the body of chuck. All screws and the boxes carrying the jaws are made of cast steel, the jaws, wrenches and scroll ring of hammered iron, the jaws and all wearing parts being case-hardened. By an improvement for which letters patent have been granted, these chucks are self-cleaning.

The self-centering Little Giant drill chucks, shown in Figs. 4 and 5, a recent invention of Mr. Westcott's, are simple, direct and positive in their action, with capacity to hold drills of any size or shape within the limits named for each size.

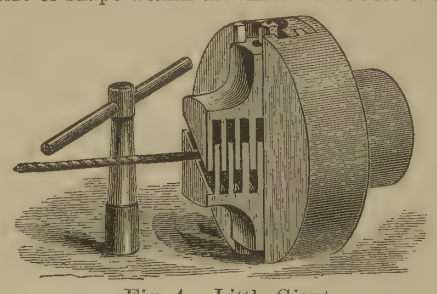


Fig. 4.—Little Giant.

Ludlow's Patent Slide Valves.

(Made by the Ludlow Valve Manufacturing Co., Troy, N. Y.)

Fig. 1.

Fig. 1 shows a quick moving slide stem and lever valve, with a simple arrangement by which the gate is held firmly at any desired point, in opening or closing. The small lever, C, acts as a nut on the bolt passing through the jaws which form the top of the plain valve stem. The lever, B, moves the gate as required, when a slight movement of the small lever, C, compresses the jaws, thus fastening the large lever securely. On small brass valves, a wheel takes the place of the lever, C.

Fig. 2 represents a single gate iron valve. A is the valve body, B the valve or gate partly open, and ground to fit its face, C.

The rear of the valve box is formed with two wedge-shaped projections, E E, as shown in Fig. 8. Between these projections and the back of the gate is the wedge, G. This wedge works loosely up and down on the back of the gate ; so that when opening the valve it may start first, setting the gate, B, free. The stem works in a brass nut, cast in H, which is a part of the wedge. This stem raises and lowers the wedge, and thus only acts upon the gate.

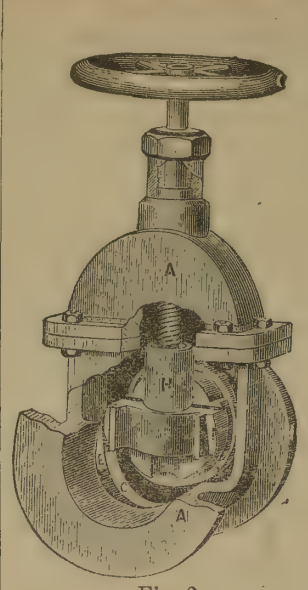


Fig. 2.

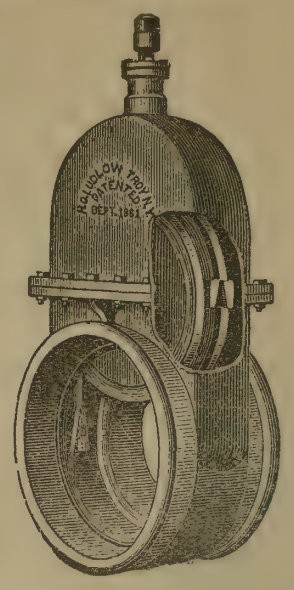


Fig. 3.

Fig. 3 shows a double large valve, intended to bear heavy pressure either side of the gate.

Fig. 4.

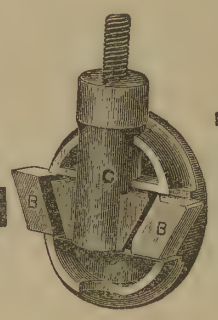


Fig. 5.

Fig. 6.

Fig. 4 represents one of the gates with two solid brass wedges, also, stem and nut. The brass double inclined plane, E, in Fig. 3, is prevented from moving up and down, but has a slight lateral motion, thus adapting itself to both the wedging surfaces of F F, in Fig. 4. The double gates rise and fall, and are pressed to their seats precisely in the same way with the single gates. Figs. 5 and 7 represent the solid brass diagonal wedges and parallel seats for the smaller double water valves. As the valve closes, the short diagonal pieces, B B, are crowded by two stationary inclines against the wedge nut, C, which is thus pressed outward against the second gate, separating the two gates till they bear tightly against their seats. In opening the valve, the wedge nut, C,

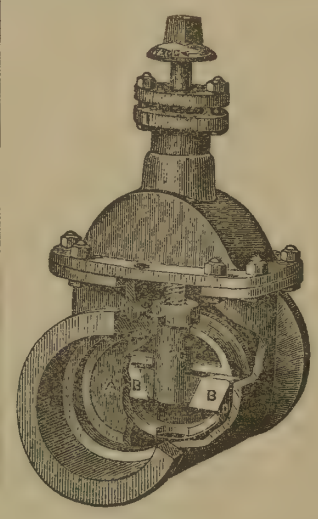
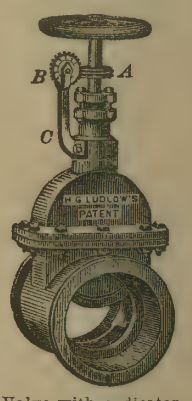


Fig. 7.



Valve with indicator, showing position of Gate.

Fig. 8.

rises first, thus relieving itself from the pressure of the pieces B B, and also relieving the gates.

When desired, a simple indicator can be attached to the larger valves, showing on the figured brass index wheel B, Fig. 8, the position of the gate. The firm also makes brass valves with a plain brass or iron rod, passing through a stuffing-box in the cover, rising and falling with the gate, and showing its position.

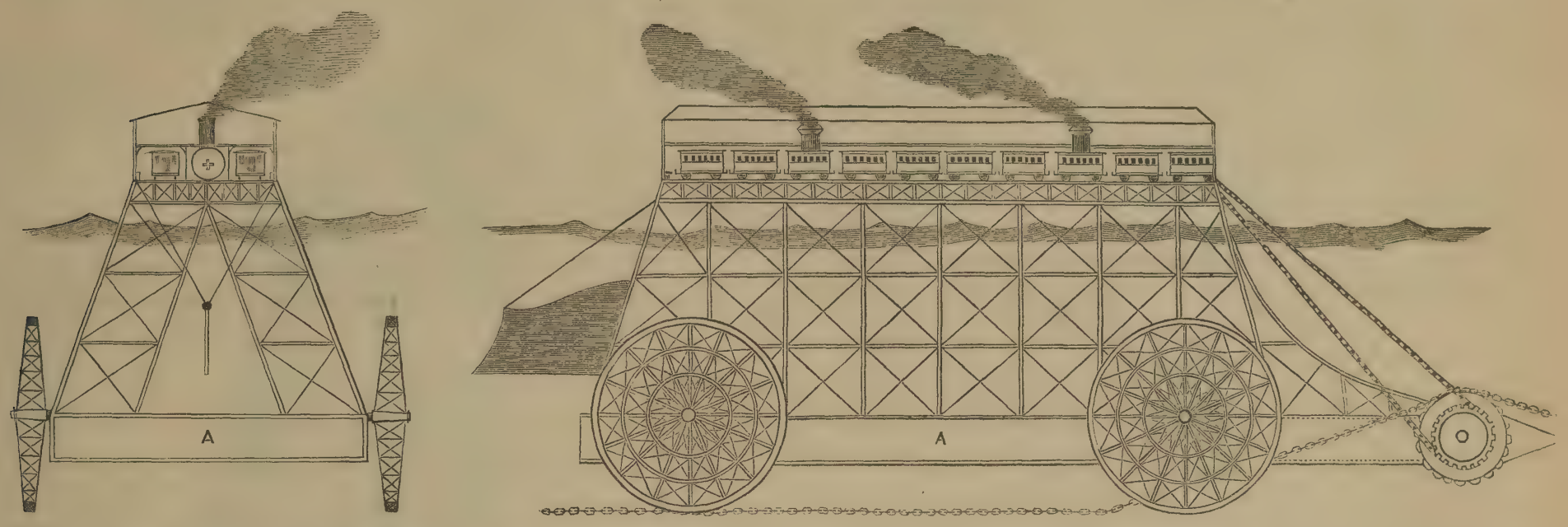
A Heavy Belt. Messrs. P. Jewell & Sons, Hartford, show a double belt 147½ ft. long, and 36″ wide ; and weighing 1130 lbs, or over 2.57 lbs. per square foot. This is claimed to be the heaviest belt, per surface, in the Exhibition.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, OCTOBER 14, 1876. NO 15.

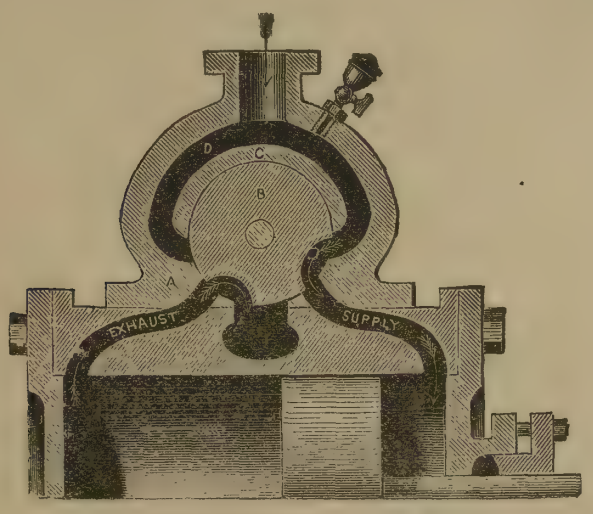


MOTTIER'S PROJECT FOR CROSSING THE ENGLISH CHANNEL.

We present herewith two cuts showing the plan of Mons. A. Mottier, of Paris, for crossing the Channel. The bottom of this last is comparatively level; the depth of water about 40 meters, or 130 feet. The line proposed is that from Sangatte to Deal. It is proposed to raise a causeway of some 10 meters in hight, 4 in width, and 2000 in length. On this it is proposed to run a vehicle 100 meters in length, 40 wide and 40 high, and composed of a pontoon at the base, and a platform above the water, united by suitable framing; the bulk and weight so calculated as to throw no weight on the wheels, which are to be 25 meters in diameter. The wheels are to be driven by an engine on the platform, which last is large enough to accommodate a railway train. Mr. Mottier makes the following estimate of the expense:

For the causeway	$800,000
" vehicle	1,200,000
" contingencies	400,000
Total	$2,400,000

His estimate of the receipts is based upon twenty trips *per diem*, each bringing in say $400, or $16,000 *per diem;* certainly a liberal enough estimate.



TALLANT'S CIRCULAR SLIDE VALVE.

The balancing of slide valves has probably occupied more of the inventor's attention than any other part of the details of steam engines. The amount of power lost, so far as useful effect is concerned, in the duty of moving a slide valve on its seat, is an unknown quantity, varying according to the conditions of each individual case; but in any event it is a very serious one, and hence the pertinacity with which progressive engineers have followed up any device or invention which gave promise of remedying the evil. In most of these devices there have been either joints difficult to keep steam-tight, and involving a serious amount of friction, or else the end has been sought through a multiplicity of parts which destroyed the simplicity of the slide-valve movement.

In order to arrive at as just an estimate as possible of the amount of power necessary to move a slide-valve upon its seat, we may first multiply the area of the valve by the steam pressure, which will give us the pressure with which the valve is forced to its seat, and this divided by the equivalent of friction, will give us the amount of power required to move the valve, which multiplied by the distance in feet moved through by the valve per minute, will give us the horse power consumed in moving the valve.

Suppose, then, a locomotive has slide-valves 16×10 inches, the steam pressure being 150 lbs., the valve stroke being 4½ inches, or 9 inches travel per revolution of the engine, the equivalent of friction being ·20. We have, then, 16×10×150×9÷12× ·20=3,600 for one valve, or 7,200 foot pounds for the two valves. Now, an engine having 5-feet wheels, and running at the rate of 35 miles an hour, will make 354 revolutions per mile, or 12,390 per hour; and since the valves require 7,200 foot pounds of power per revolution, we have 2,763 horse-power per hour as the loss due to the friction of the valves on their seats. That this loss is actually incurred in properly fitting valves, the following facts go to prove. Mr. Joshua Rose, of New York, has in the Centennial Exhibition, in the Putnam Machine Co.'s exhibit, a pair of surface plates, 12×8 inches, and beside them is a certificate from the Fairbanks Scale Co., certifying that it took a pressure of 341 lbs. to slide one plate upon the other (the surfaces being as smooth as glass). Now, supposing there to be the whole of the atmospheric pressure forcing these plates together, a simple calculation will demonstrate that our equivalent of fraction of ·20 is too small, and that in our above calculation we have under- rather than over-stated the case, since the equivalent of friction as given by Mr. Rose's plates is 23 instead of 20, as allowed in our calculation. We made this allowance because of the unusually close fits of Mr. Rose's surface plates. That the data obtained from these plates is not exceptional under a perfect fit, is attested by the fact that three of them, on exhibition at the American Institute Fair, give a precisely similar result.

The necessity, then, of relieving an engine of this great load being demonstrated by both theory and practice, we may turn to one of the latest devices designed to obviate it, and this will be found in our illustration, which represents Tallant's Patent Circular Slide Valve. The advantages claimed for this method of construction are a total absence of the enormous pressure referred to, save that sufficient to ensure, under all conditions, a working steam-tight fit; and as a result, the valve can be shifted with one hand on any size of engine when under steam pressure; the operation being performed with perfect ease, a feat altogether impossible withe ordinary slide-valve, providing that it is a proper fit to its seat. As a result, then, there is a rapidity of action and an absence of spring in the valve gear, unattainable in any other case.

Not only will an engine of a given size, and having these valves, perform more duty, but it will do so with a less consumption of fuel, for every pound of useless duty is represented in the coal pile.

By referring to our engraving, it will be seen that the action of the steam upon the side of the steam port in the valve, is to press upon the valve in the direction of its movement, thus assisting the eccentric in its duty, and at the same time relieving the seat of a portion of the weight of the valve itself, the remainder of the weight serving to keep the valve to its seat, even though, from very long use, excessive wear had taken place. The shape of the steam port in the valve can be so proportioned as to relieve the seat of just so much of the weight of the valve as is found to be the most advantageous in actual practice. The action of the eccentric is, in this case, to simply permit the valve to perform its travel of itself, and to check it from superfluous movement. This is a great advantage, because all the advantages due to an excess of valve travel

(over and above that necessary to open the steam ports, and which is an especial feature of American locomotive practice) can be obtained without the loss from friction which such excess involves. This extra friction is in amount in precise proportion as the valve travel is increased above the 4½ inches given in our calculation. (By referring to Forney's Catechism of the Locomotive, we shall find that the valve travel of an ordinary locomotive varies from 4½ to 5½ inches). So highly important is the friction induced by extra valve travel considered by English locomotive engineers, that they rarely resort to it, from a feeling that the gain due to a more rapid steam supply due a more equal expansion and exhaust is offset, or very nearly so, by the increase of friction involved. In the case of the balanced valve, however, the amount of friction due to increased travel is so small as to be of no practical import whatever.

Another advantage possessed by this form of valve, is that the steam passages are much more nearly straight, and the friction of the steam upon the sides of the passages is reduced proportionately, and that this element is of practical importance is readily perceived by perusing the remarks made upon it in "Auchincloss on the Slide Valve."

The Tallant patent circular slide-valve consists of two parts: a circular steam-chest (A), containing a circular valve, operated, in the usual way, by an eccentric on the driving shaft; an iron arch or shield (C), covers the back of the valve (B), and protects it from steam pressure, the part of the valve exposed to steam and containing a section of the steam ports being to assist the eccentric, as already explained, in performing its functions. The fit between the shield and the valve is just sufficiently close to permit of easy movement, thereby inducing a water packing, which serves also as a lubricant and prevents abrasion or wear. The action of the link motion is not at all affected by the application of this valve, and since the area of the valve seat bridges is equal upon all four of them, the wear also is equal.

For further particulars, address the manufacturers, Messrs. Bayliss, Vaughan & Co., Richmond, Indiana.

NITRO-GLYCERINE.

The remarkable substance nitro-glycerine, which has of late attained to such importance in the useful arts, may be looked upon as a type of a peculiar class of bodies which chemists term nitro-compounds. A glance at the history of these substances and the means that led to their discovery, will be found of interest.

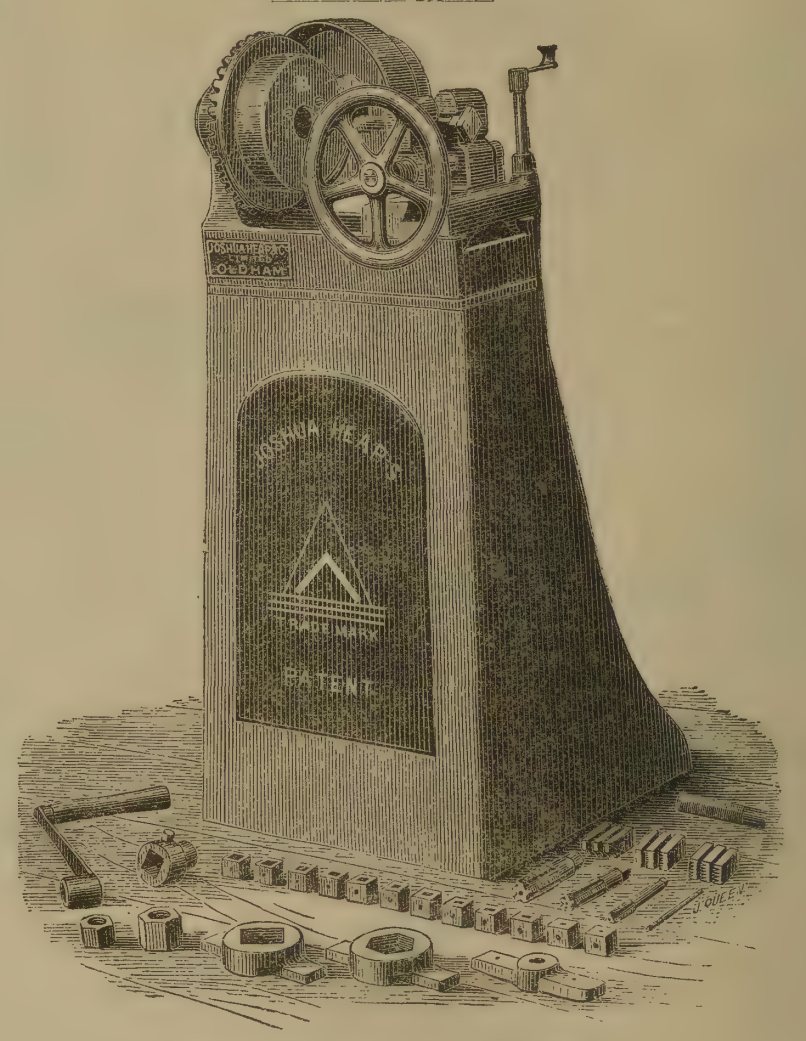
Some thirty years ago, Schönbein, a German chemist, was engaged in seeking for an explanation of the remarkable fact that, whilst iron is violently attacked and speedily dissolved by nitric acid, or a mixture of nitric and sulphuric acids, when water has been added to them, yet, when these acids are concentrated, that is, only containing the water necessary to render them liquid, the metal is not attacked by them, but remains apparently quite indifferent and unchanged. The peculiar surface condition thus produced, and which can be brought about with other metals besides iron in the same manner, is known as the "passivity" of metals. In the course of his experiments to elucidate this phenomenon, Schönbein was led to submit a number of organic substances to the action of the concentrated acids named above. He immersed some cotton in the acid mixture; it appeared unacted upon. It was removed from the acid, pressed, washed, and placed near the hot stove of a drying chamber to be dried; on going to examine it, lo! it had disappeared. Another parcel was similarly treated, and the attempt was made to dry it over a hot stove, when suddenly it disappeared with a flash; and on repeating the experiment, but drying in a current of cool air, the extraordinary substance now so well-known under the name of gun-cotton, was produced. Schönbein patented his discovery in 1846.

The remarkable properties of this substance attracted wide-spread attention to it, and the most sanguine predictions as to its future utility in the arts were indulged in. At the same time there sprang up amongst the learned an animated controversy respecting its nature—whether it should be regarded as a definite chemical compound, or as a mechanical mixture, acquiring its characteristic properties by the absorption and retention of some of the nitric acid within the interstices of the cotton. The latter explanation appeared to be the most probable, inasmuch as any decided chemical change in the constitution of the cotton would appear to necessitate some visible change in the structure of the delicate cotton fibre—which the gun-cotton does not display. The former explanation, however, was finally shown to be correct, through the labors of Crum and Sobrero. The former affirmed that gun-cotton is a true chemical compound, in which some of the hydrogen of the cotton is replaced by nitric acid; and the latter, in 1848, demonstrated the correctness of this view, by manufacturing a number of analogous explosive preparations from dextrine, mannite, cane sugar, and glycerine. Sobrero, therefore, is the discoverer of nitro-glycerine.

For a number of years nothing was heard of the discovery of Sobrero, until the breaking out of the Crimean war, when Prof. Jacobi is believed to have turned it to account; certain it is that rumor declared at the time that this chemist had furnished his august master, the Czar, with a terrific explosive for charging torpedoes. This explosive, it has since transpired, was nitro-glycerine, and although at that time the imperfect knowledge of the proper methods of making and handling it on the large scale rendered it perhaps more dangerous to friend than to foe, it is not unlikely, as rumor further hath it, that the terror which the bare suspicion of its employment as a defensive agent inspired, sufficed to save Cronstadt from falling into the hands of the allies. Meantime, gun-cotton was being experimented with largely for military uses, and it seemed not improbable, as its admirers affirmed, that it would shortly supplant gunpowder in all its uses. Several of the European governments, notably France, England, and Austria, expended large sums of money in the hopeful effort to effect such improvement in the methods of its production, manipulation, etc., as to warrant its adoption on the large scale as a substitute for gunpowder. In spite, however, of vast outlays of money, and the skill of the most eminent scientific engineers, these hopes have thus far not been realized.

In 1864, eighteen years from the date of its discovery by Sobrero, Alfred Nobel, a Swedish engineer, inaugurated what was subsequently destined to develop results of incalculable value, by applying nitro-glycerine to blasting purposes. Since that time, in the face of the most serious obstacles, the nitro-glycerine industry has grown to immense proportions; numerous manufactories have been established in Europe and America, and its annual consumption reaches to hundreds of tons. The experience that has been gained during these years has been attended with notable improvements in the manufacture of the explosive, and in the establishment of such efficient precautionary regulations respecting its transportation and use, that the popular prejudice which it had at first most violently aroused has been practically allayed. It has come to be recognized as incomparably the most powerful and effective explosive agent that has yet been discovered, and its value has become so generally acknowleged by engineers, that it has largely replaced gunpowder wherever blasting work of any magnitude is undertaken; indeed it is not affirming too much to say that many of the most extensive and important recent works of internal improvement owe their existence to it; certain it is that some of them, already completed, or in course of construction, would have been pronounced impracticable, had not science armed the engineer with a weapon tenfold more powerful than gunpowder. W.

(To be continued.)



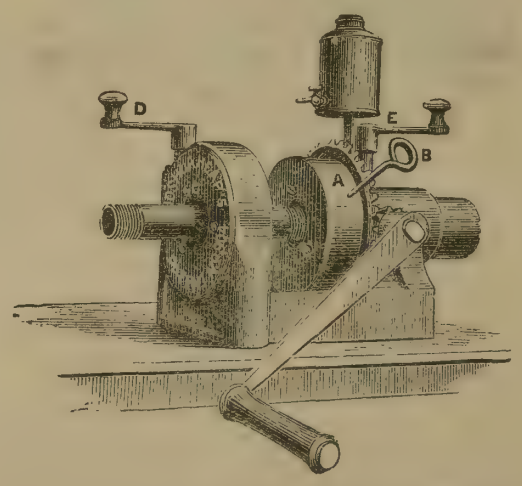
HEAP'S BOLT-SCREWING MACHINE.

B 15, BRITISH SECTION, MACHINERY HALL.

[*Made by Joshua Heap & Co., Oldham, England.*]

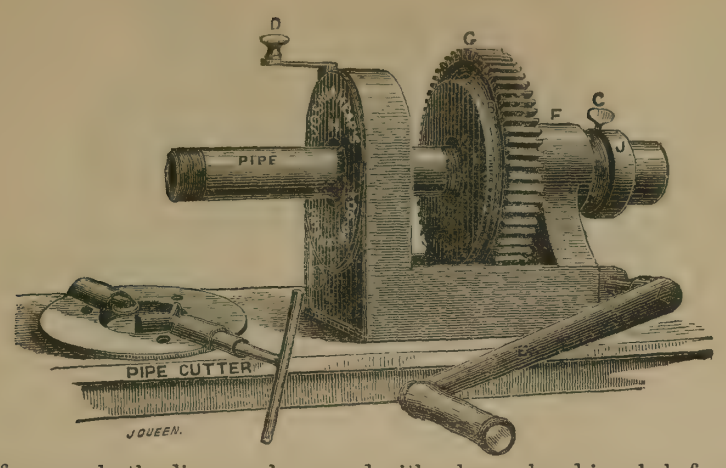
This screwing machine can be worked by hand as well as by power, and screws, bolts and taps, nuts from ¼″ 1½″ inclusive, "at once over."

The vise is very strong, but occupies a very small space, half of one jaw passing under the other, giving strength and stability. The jaws are worked with a right and left-hand screw.



The screwing dies revolve, and the bolt is stationary and forced in the dies by a pinion which works in a wrought-iron rack. There are three screwing dies in one set, and one set to each pitch of thread, and not to each size; for example, the ½″ and $\frac{9}{16}$″ are screwed with one set, and so are the 1⅛″ and 1¼″, also the 1⅜″ and 1½″ bolts.

The ring A is marked for the different sizes. The dies are changed by taking off the plate B. In screwing, the dies are first set to the size, and the bolt fixed to the vice, and when screwed far enough the screwing head is reversed, and returns three times quicker than while screwing. But if used as a hard machine, when the bolt is



screwed far enough, the dies may be opened with a lever placed in a hole for that purpose in the ring A.

When tapping, the screwing dies are replaced with three blank dies, which hold a chuck for turning the tap, and the vise dies are also replaced with nut holders (which, with tap holders for each size, are supplied with the machine.)

There is a capstan head for holding bolts up to $\frac{3}{4}''$, where a large quantity of short bolts are to be screwed (for bolt makers). The machine is kept continually working, the bolts being put in whilst it is screwing.

It is claimed that in all these machines no filing of the outside scale on the pipe, or swaging of the bolt is required; as they cut the scale away clean, and at the same time reduce the pipe or bolt; and that they will not split an irregular pipe, as is often the case with the old system.

The large size is claimed to screw 17 gross of $\frac{3}{4}''$ bolts $1\frac{1}{2}''$ up per day of nine hours. It is claimed that the dies will screw upwards of 350 gross before they are worn out.

THE CERAMIC DISPLAY AT THE CENTENNIAL.—We beg to announce our intention of publishing at no very distant date a special issue of the REVIEW, in which the subject of Ceramics at the Centennial will be treated at length and with great completene s, by a very competent writer.

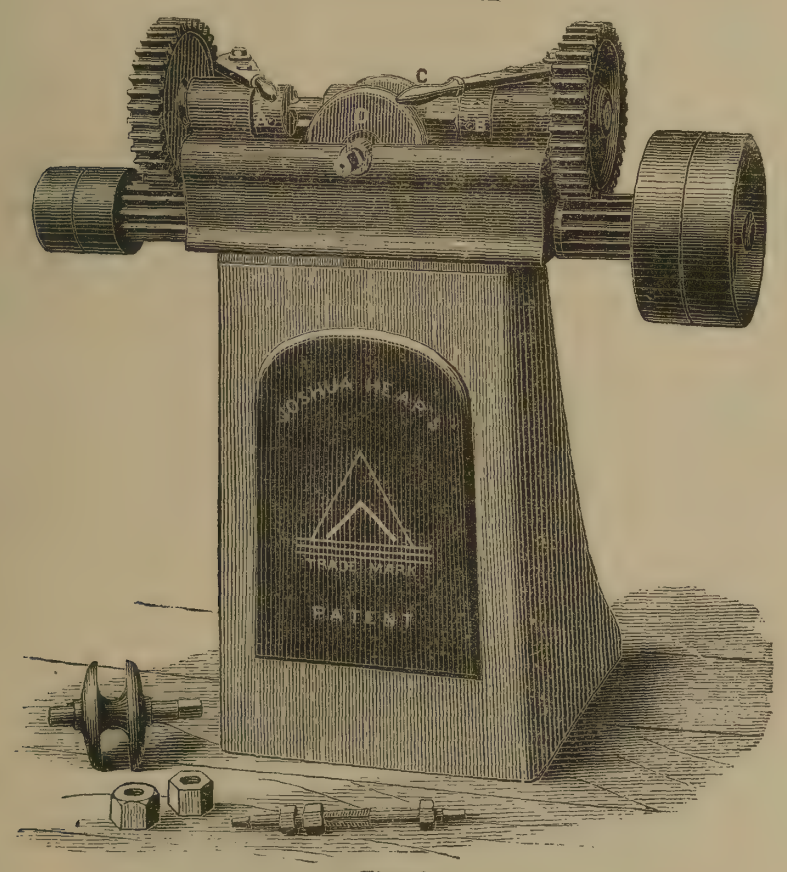


Fig. 1.

HEAP'S NUT TAPPING MACHINE.

B—15, MACHINERY HALL.

[*Made by Joshua Heap & Co., (L't'd.) Oldham, England.*]

This machine is very simple in its construction. Only one tap is used, but owing to its peculiar form it can be run at a much higher speed than an ordinary tap; as it is always tapping, the work can be done at a cheaper rate and with less work for the operator, than with the 3, 4, or 6 spindle machines, as it is impossible to keep their taps constantly working.

This machine will tap from $\frac{1}{4}''$ to $\frac{7}{8}''$, inclusive, and is guaranteed to tap 10 gross of $\frac{1}{4}''$, $4\frac{1}{2}$ gross of $\frac{5}{8}''$, and $3\frac{1}{2}$ gross of $\frac{7}{8}''$ nuts per hour.

The tap is quite a new feature, (and is patented) having a squared shank at each end, so that it may be driven from each end alternately as the nuts are put on or taken off.

To work the machine:—The shank at the taper end of the tap is first filled, and the nuts are forced on with the lever A, and as the nuts pass over the tap the lever A is drawn back and more nuts put on while the tap is being driven from the other end, when the shank at the opposite end is full, the nuts force the chuck, B, away, and as soon as loosened it is pushed far enough by lever C, the nuts are then pushed off and they drop through the machine. The lever is then pulled back again.

This is done rapidly, and while a nut is being tapped, the operator has plenty of time to keep the machine working and the tap constantly tapping.

The nut-holder, D, is a disk, which is revolved by the nut passing through, and assists the following nuts on to the taps.

This machine forces out the burr that is often left in the hole from the finisher's hammer, which in many other machines has to be cleaned out before the nuts can be tapped.

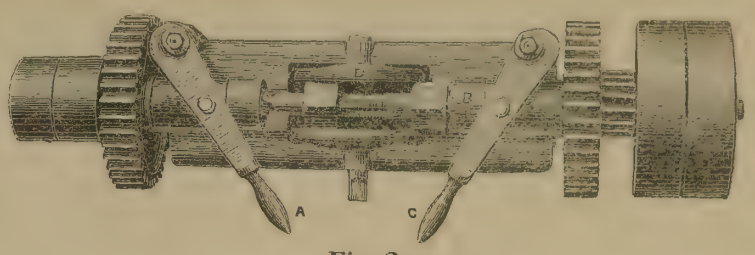


Fig. 2.

The lubricating mixture is forced on to the tap with a small force-pump, which gives a continual supply, and keeps the tap from getting hot.

This machine is mounted on a stand which forms a cistern.

The cuts, unfortunately, show the wrong side of the machines. In Fig. 2, the crank shown in front operates, by means of a pair of bevel wheels, a long pinion at the back, which drives the main spur-wheel, G. J is a "rotating journal" which, after the first few threads are cut, may be locked by means of the screw, C. The crank, D, operates the chuck, which holds the pipe. In the smaller machine, Fig. 1, the speed is lessened by gearing.

BACK NUMBERS OF THE REVIEW.—Owing to an unprecedented demand for back numbers of our journal, principally to complete sets for foreign and domestic subscribers, we cannot supply copies of most of our back numbers, previous to No. 10 of the current volume, to *any but full paid yearly subscribers.*

NYSTROM'S STEAM ENGINEERING.

In a previous issue we promised to reproduce some characters of notation used in Nystrom's new treatise on Steam Engineering, as it is desirable that they should be adopted as standard notations, so that we may understand at a glance not only what the letters or characters in a formula represent, but also to what branch of science the formula belongs.

P=Absolute steam-pressure in pounds per square inch.

p=Steam-pressure in pounds per square inch above that of the atmosphere.

$\dot{V}$=Steam-volume compared with that of its water.

$\boxminus$=Area of fire grate in square feet.

$\square$=Area of heating surface in square feet.

HP=Horsepower in operation, Watt's unit.

W=Cubic feet of water evaporated per hour from temperature 32° Fahr. Then, Mr. Nystrom says, that in ordinary steam-boilers the average evaporation with natural draft is,

$$W = 0.4 \sqrt{\boxminus \square}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 1$$

The natural effect in horse-power of a steam-boiler is

$$HP = \frac{P(\dot{V}-1)\sqrt{\boxminus \square}}{34400}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .$$

The legal (as he calls it) horse-power of a steamboiler should be

$$HP = \frac{p(\dot{V}-1)\sqrt{\boxminus \square}}{34400}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 3$$

The nominal horse-power of a steam-boiler should be

$$HP = \frac{\sqrt[3]{p}\ \sqrt{\boxminus \square}}{6.88}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 4$$

We cannot vouch for the correctness of the formulas because we have not yet had a chance to apply or check them; but we recommend the notation as impressing the mind at once with what it means. We therefore hope that writers on steam engineering and on physical sciences in general, will adopt Mr. Nystrom's notation as the standard, in order to enable us to read their books without the confusion of learning a different notation for each formula.

The notation can also be advantageously used in abbreviating the text. For instance, instead of writing over and over again the expression, "*area of fire grate in square feet,*" we need put simply the sign $\boxminus$.

Mr. Nystrom uses other characteristic notations, for which we refer to his excellent work on Steam Engineering.

ENLARGEMENT OF THE "REVIEW."—In addition to our recent change from a monthly to a weekly journal, we contemplate an early increase in the quantity of our reading matter. Aid us by sending subscribers.

AMERICAN BRIDGES IN BRAZIL. We have reliable information from Senhor Coutinho, of the Brazilian Centennial Commission, that the American system of bridge building will be introduced in the Brazilian Empire. The announcement will be received with pleasure by our American bridge-constructors.

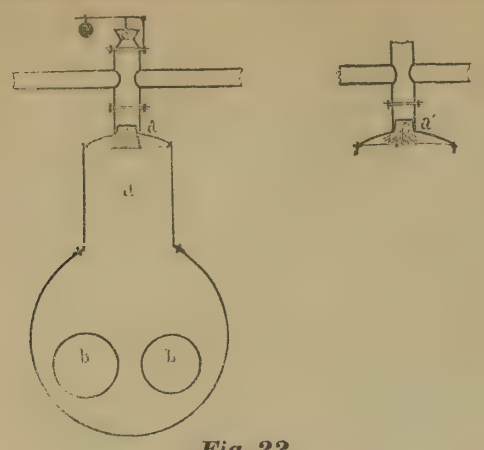


Fig. 22.

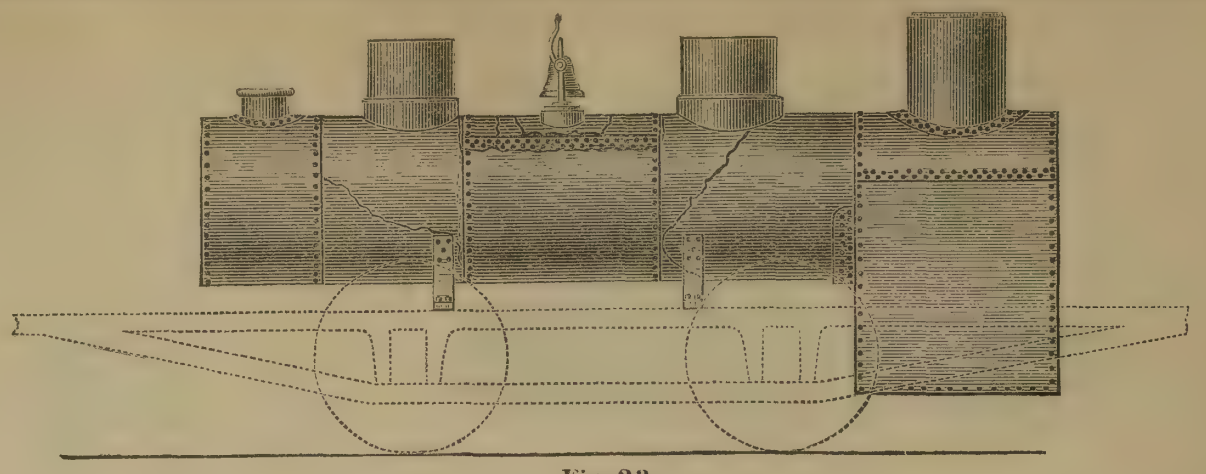


Fig. 23.

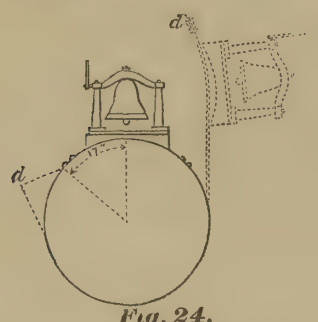


Fig. 24.

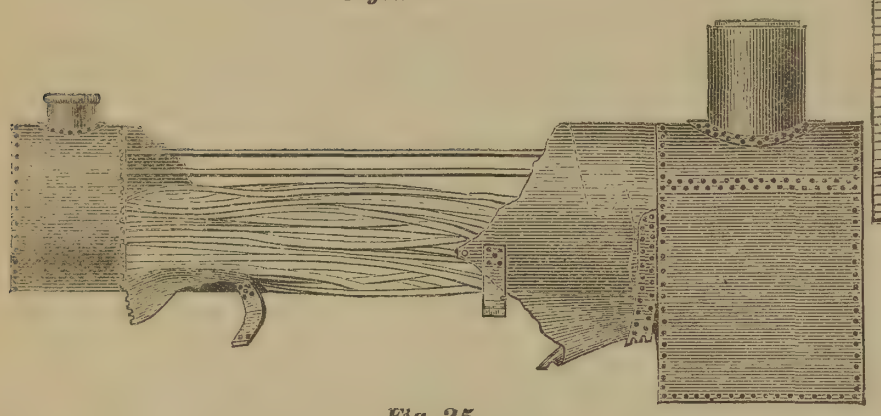


Fig. 25.

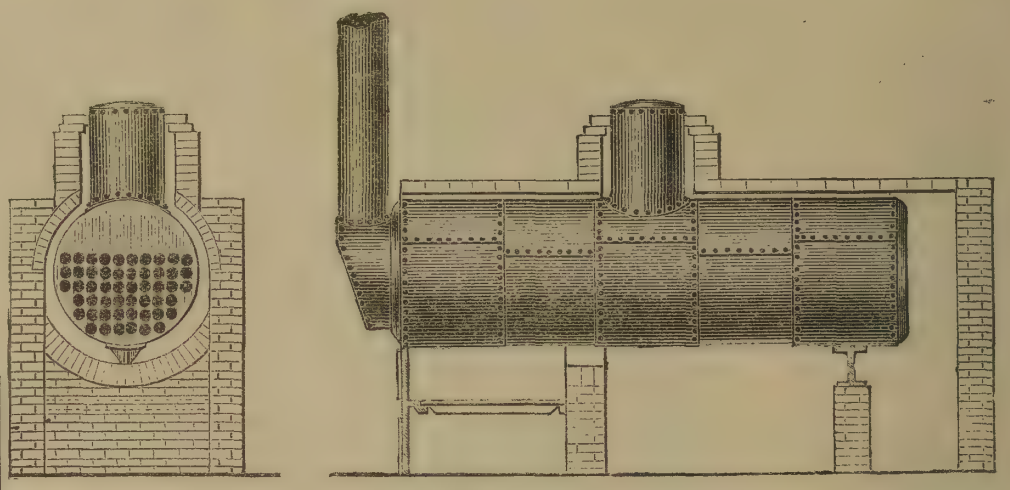


Fig. 26.

ANNUAL REPORT OF THE HARTFORD STEAM-BOILER INSPECTION AND INSURANCE COMPANY, 1875.

COMPLETING THE FIRST DECADE.

IV.

"In the early part of this report I alluded to an explosion in the Chrome Works at Baltimore, which was the result of carelessness. The boilers in these works are horizontal, with two flues, and constructed of 5-16ths iron. They are 31 feet long, 4 feet in diameter. The flues are 27 feet long and 16 inches in diameter. The explosion occurred Jan. 11, 1875. A safety valve of sufficient capacity was placed above the steam pipe connections, as represented in Fig. 22.

As has already been stated, repairs were necessary and were being made, when the workman was annoyed by hot water dripping on to him from the opening of the steam pipe overhead. (This boiler was connected with another; a stop-valve between them was closed, the other boiler being in use, but the valve leaked.) He prepared a wooden plug and drove it into the opening, as will be seen at *a*. When his work was done he entirely forgot the plug and left it driven into the only steam outlet which the boiler had. He put the manhead in place, the boiler was filled, and fires started. In about four hours an explosion occurred, doing some $15,000 damage, and killing and wounding several people. This was a piece of consummate carelessness. There was no mystery about it.

In August, 1875, a locomotive exploded on the Fitchburg Railroad, at Charlestown, Mass. It was used as a shifting engine. The boiler was 40 inches in diameter, made of 5-16ths plates, and run at 125 pounds pressure. The fracture commenced at the seam directly under the bell, Fig. 23.

At this point it was ascertained that there was an old crack which left but a comparatively small percentage of sound metal. The fracture followed this seam and then found its way down the girth seams, and from thence extended to the plates on either side. The bell was thrown a long distance. It left the boiler as represented in Fig. 24.

The boiler was not thrown off from the frame, but its condition was something like that represented by Fig. 25.

There have been some departures of late years from what we regard the correct principle in setting boilers. These plans have been devised for the purpose of attaining greater economy, and under some circumstances such a result may have been accomplished. I refer now more particularly to the methods of setting, whereby the boiler is enclosed, as it were, in an oven, and the heat allowed to rise and envelop it entirely. It is claimed that inasmuch as there is no draft upward, around the boiler, the heat that rises simply from rarefication cannot be injurious to the iron of the boiler. And further, that this enveloping heat will give partially superheated, and consequently dryer steam. This form of setting will be better understood by reference to Fig. 26.

Our experience with this setting goes to show that there is great liability to the brick work cracking on the top and around the dome, in which case the heated air tends in that direction. A case where there were six boilers set in this way came under our care. One of them cracked within one foot of the top near the back end. On investigation the evidence of being burned was so apparent that to prevent further trouble the boilers were all reset and closed in at water line.

In another instance, two horizontal boilers required resetting. Upon removing the old setting it was discovered that near the back end and above the water line both boilers were bulged out, having been red hot. It became necessary to throw them out entirely, as being unsafe.

A boiler with this plan of setting, running in Connecticut, was ruined, having been red hot on top nearly its whole length. The sheets were cracked in several places. It is fair to say, that in this case a blower was used.

Several boilers have been found injured and cracked at the back tube sheet,—cracked and bulged from not being closed in at water line. Numerous other cases might be mentioned where the damage has not been so serious. Wood and soft coal should never be used under boilers set in this way, and under no circumstances should a blower be used.

We have experienced no little trouble from this setting by the accumulation of sediment at and above the water line, where it is thrown by the action of the water, and becomes baked on to the plates.

Little or no saving can be made by this setting when a boiler is used as it should be. The injury to the boiler may not be apparent by bulges and cracks for some time, but there is a gradual and permanent injury to the fibre of the iron, rendering the boiler unsafe in time, even at the ordinary working pressure."

FIRE PROTECTION.

TREMBLEY'S HOSE ATTACHMENT.

The device shown herewith is an attachment to an ordinary stationary wash-stand, by which a hose can be attached and used in case of an incipient fire in a chamber. The idea is a good one, and the apparatus should not be expensive. It is patented by D. G. Trembley, 103 South Fourth Street, Brooklyn, N. Y.

CONCERNING SPONTANEOUS COMBUSTION.

VII.

Spontaneous ignition has repeatedly been observed to take place with hay and similar substances, when stacked in heaps, while yet damp. This phenomenon has lately been described with much minuteness from personal observation, by M. Ranke,* an abstract of whose observations we herewith append.

Two stacks of second crop hay, containing respectively about twenty-two and fifteen tons, in apparently perfect condition, were formed in a barn, between the 5th and 10th of August, during excellent weather. The usual strong hay aroma was perceptible, increasing in intensity until the 17th of October, when it was replaced by an empyreumatic odor from the larger stack, which had a length and height of twenty-three feet, and a width of sixteen feet. Although externally the color and temperature were quite normal, the removal of the hay was commenced on the 19th. The upper portions were so sweated that drops of moisture had accumulated on the hay. At the depth of three feet, and in another place in only one and a half feet, the hay became dry and hot, and a distinct empyreumatic ordor was recognizable. At five feet, sparks appeared in the stack, and simultaneously, also, among the hay that had been thrown on the wagon, although water had been applied to the stack. At intervals after this, flames occasionally appeared among the hay on the wagon. In cutting out a space to separate the larger from the smaller stack, which last was unaffected, such quantities of an irrespirable gas, probably carbonic oxide, were given out, that the workmen were driven back in a very few minutes. The burning portion seemed to form a central nucleus to within one and a half feet of the bottom. It was in the condition of true carbon, with complete retention of the structure of the grass, and the property leaving a streak on paper.

It seems, therefore, that hay in decomposing in this way is converted into a highly porous carbon, contaminated with matter strongly predisposed to rapid combustion, and possessed, when heated, like many other porous carbonaceous substances, of pyrophoric qualities. The presence of a considerable amount of empyreumatic matter and some moisture was demonstrated by heating some of the decomposed substance in a flask. After expulsion of these volatile matters by continual heating, it cooled in ths open air without igniting. Upon heating to 482°—570° F. in a flask over the oil bath, and then pouring it on a table in a little heap, it rapidly fell to a temperature that could be borne by the fingers, but very shortly it rapidly heated, and suddenly portions of it began to glow.

The fact of spontaneous ignition being thus established, it remains to investigate the progress of the change in a stack of hay, which produces the elevation of temperature necessary for carbonization. The normal temperature and external appearance indicate that, owing to the poor conducting power of hay, all the heat evolved by chemical changes in the interior is accumulated there. As practical precautions against conflagrations from this source, careful drying before stacking is recommended, also, that the stacks be not too large or confined, and finally, that intermediate layers of straw, or of boards or poles, be introduced in such a way as to insure or facilitate ventilation.

In the third division of our classification, are included the spontaneous combustion of explosive and allied compounds. Many bodies of this character are known to the chemist that are practically unknown outside of the laboratory. In the preparation of fireworks there are many mixtures containing the chlorate of potassa, (and other chlorates and nitrates) that are liable to manifest this phenomenon. This is notably the case with the popular mixtures for producing colored fires; and here, as in other cases, the presence of moisture, if not indispensable, at least materially hastens its occurrence. In such cases, however, besides the precautionary measure of keeping the preparations dry, it is worth noting that the addition to them of a small quantity of sulphuret of antimony has been found to render them practically safe from this form of danger.

With the better known explosives—gunpowder, gun-cotton, and the several forms of nitro-glycerine—no danger is to be apprehended from their spontaneous ignition when they have been properly prepared. With gunpower this is emphatically the case, while with the others, although when first introduced, and their properties but imperfectly understood, strong protests were urged against them on this score, the testimony of those who are best informed concerning them, and most familiar with their practical manipulation, is unanimous in declaring their entire freedom from liability to explosion in this way. In the early history of these valuable explosives, accidents have occurred which lent an air of plausibility to the theory of their spontaneous origin; but the facts in such cases are so obscure that, when the occurrences are taken together with the total absence of recurrence at the present time, when we know so much more of them—and their use has enormously increased—any such prejudicial inference based upon these premises would be both unwarranted and unjust.† W.

[*To be continued.*]

*Annalen d. Chem. u. Pharm.—1873; clxvii. Quoted in *Harper's Annual Record*, 1873, 423.

†Consult *Mowbray*, on Tri-nitro-glycerine as applied in the Hoosac Tunnel. D. Van Nostrand, New York.

WATER METERS.

Curiously enough, while no one under existing social arrangements would listen for a moment to a plan for averaging the grocery or gas bills of the householders in any city or town, the custom obtains very largely to charge each one for the water furnished him by the municipality, not according to his wastefulness or actual consumption, but on an average charge of so much a head. It is time that some attempt is made to equalize the thing, and an acknowledgement is made of the evident unfairness of the "lumping" system, by charging one according to the opportunities or temptations he may have for consumption of water: Thus, he who has two hydrants that are almost annexed, pays more than he who has one hydrant conveniently placed, and on which a continual demand is made. A house-owner whose love for the beautiful leads him to provide a fountain for the public delectation, pays for the plashing jets, whether he turns them on or not; and should his absence for months silence the fountain for a lengthened period, the tax flows on, though the spray has ceased to cool the air. On the other hand, where two parties are taxed equally for the use of that institution so peculiarly or prominently Philadelphian,—the wash pave,—there might be some injustice done to one of the tax-payers, from his less frequent and excessive use of that housemaids' delight, were it not for the fact that by a generous rivalry on the part of the Milesian domestics, the consumption is kept up with very little difference between the competing households. The average small boy, too, delights in the wash-pave; and on rainy days in particular he may be seen making experiments in hydraulics at the city's expense, much to the terror of the passers-by. As for Miss Bridget, (God bless her and teach her many, *many* things) she "riseth early in the morning," arms herself with bucket (*Anglicé*, pail,) and mop or broom, and sallies forth (no pun intended) to a task of two hours' duration—the washing of four windows and an 18-foot pavement. Meeting Miss Celia, (may there be unto her sweet peace,—and the art to broil a steak properly) the streams of conversation and of city water flow on together. "Men may come, and men may go; but they flow on forever."

The extreme care bestowed by a large force of men upon the cleanliness of our streets and navy yards, just prior to an election, finds its only parallel in the persistence and patient, uncomplaining industry with which, early in the morning, these drawers of water prepare our front pavements for the muddy feet of the workmen, shopward trudging.

Should, however, a citizen wish a few gallons of water daily for driving a small sewing machine, or an organ, the city of Philadelphia, with a guardianship of public interest truly astounding, and worthy of record in enduring brass—or lead—throws to the wind the banner of economy, and sounds the dread tocsin of "scarcity of water," "breach of contract," "total destruction of navigation." While a stream of water sufficient to turn a mill or float a raft is rushing from the thousands of wash-paves throughout our city, the use of water to drive the sewing-machine, the dental engine, or the organ, would be fraught with danger beyond computation!

It would seem as though the most common-sense way, and that most likely to subserve the purposes of economy, and of husbanding the supply of any city, would be to apply to the water department and to the water-consumers the same principle *nominally* applied in the supply of gas—payment proportionate with consumption. The little modification "extortionate" need not be introduced.

At first thought, philanthropists might be disposed to consider the general introduction of water-meters as a premium offered on dirt; but due consideration would explode that theory. Such general introduction with a moderate charge easily determined beforehand, would effect so great a saving in the amount of water consumed (representing millions of gallons otherwise wasted), that the actual and needed consumption would be increased, while the charges to the consumer and the cost to the city would be greatly reduced. The wasteful drain upon the mains would be stopped, and there would be more water available in case of fire, and for systematized street sprinkling.

The following table, showing the number gallons used per day *per capita* of the population, has been compiled from the annual reports of the Water Boards of the several cities named:

City.	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875
Boston, Mass.	55	59	62	62	60	54	....	....	60	62
Charlestown, "	....	42	....	....	....	....	84	61	....	....
Cambridge, Mass.	....	....	....	....	44	43	36	48	46	....
Worcester, "	....	....	....	....	....	....	89	....	74	....
Salem, "	....	....	....	....	....	....	58	....	....	....
New Bedford, Mass.	....	....	....	....	....	....	39	....	....	....
New York	....	....	....	....	....	85	88	104	90	....
Brooklyn	....	....	....	....	....	....	51	....	60	....
Jersey City	....	....	....	....	174	....	99	....	....	....
Newark, N. J.	....	....	....	....	26	....	....	....	....	....
Philadelphia	....	46	51	50	55	55	54	....	56	....
Baltimore	....	....	....	....	42	....	....	27	50	....
Cleveland, O.	22	24	25	27	31	36	40	....	43	....
Cincinnati, O.	....	....	....	....	....	....	51	....	....	53
Buffalo, N. Y.	....	....	....	....	....	....	68	....	....	....
Washington, D. C.	....	....	....	....	....	....	258	....	....	....
Dayton, O.	....	....	....	....	....	....	23	25	30	27
St. Louis	....	....	....	....	54	....	....	....	60	....
Chicago	....	....	....	....	73	....	....	....	80	....
Detroit	....	60	64	67	61	65	73	90	90	88	107

The record given above gives merely the total amount supplied, divided by the total population, including all water wasted and used in any way. The variance is astonishing.

Mr. George F. Deacon of the Liverpool (Eng.) Water Works, estimates the waste at 70 per cent. Estimates from nearly fifty cities show a waste of from 50 to 75 per cent.

To reduce this waste to a minimum, and to charge for the water actually used by each one, is not a galling restriction, but a common sense plan resulting in the greatest freedom to *use* water, at the lowest possible cost.

The following named cities have water meters in more or less general use:

Portland and Rockland, Me.; Manchester and Concord, N. H.; Attleborough, Boston, Cambridge, Charlestown, Fall River, Fitchburg, Holyoke, Lawrence, Lowell, Lynn, Medford, Natick, Springfield, Salem, Worcester and Waltham, Mass.; Bellows Falls, Vt.; Meriden, New Britain, Norwalk, Norwich and Waterbury, Conn.; Providence, R. I.; Binghampton, Rochester, Schenectady, Utica and Watertown, N. Y.; Erie, Oil City, Pittsburg and Reading, Penna.; Columbus, Canton, Cincinnati, Cleveland and Dayton, Ohio; Indianapolis and South Bend, Ind.; Chicago, Springfield and Alton, Ill.; Jackson, Kalamazoo, East Saginaw and Grand Rapids, Mich.; Rome, Ga.; Milwaukee, Wis.; St. Paul and Minneapolis, Minn.; Des Moines and Dubuque, Iowa; New Brunswick, N. J.; Lonisville and Newport, Ky.; Montreal and Toronto, Canada; Denver City, Ool.; San Francisco, Cal. G.

(*To be continued.*)

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

Experiments with a New Revolving Cannon. A special despatch from Sandy Hook to the New York *Herald* of recent date, relative to official experiments with the Hotchkiss revolving cannon, gives a description of the terrible engine and its workings, that is very grimly interesting. The following is a description of the new weapon: It consists of five barrels grouped around a common axis and revolved in front of a solid breech block, which has in one part an opening for the introduction of the cartridges, and another through which to extract the empty shell. Both operations are accomplished at the same time, and as the cartridges are fed to barrels on the same principles as with the Gatling gun the fire can be maintained continuously at the rate of eighty per minute, if necessary. The calibre of the barrels is one and a half inches and the charge weighs three and a half ounces, with a shell weighing about one and a quarter pounds. The shell is exploded by a percussion fuse and bursts immediately on striking any object it meets. The barrels are revolved by a crank which controls all the mechanism of the gun, so that really a stream of shells, like water from a fire hose, can be poured on any given point with absolute accuracy and fearfully destructive effect with scarce more difficulty than playing on a street organ. A peculiarity of the revolution of the barrels is that they stop to discharge, so that the accuracy of the fire is not in any way impaired by a continuation of the revolution at the moment the firing pin strikes the exploding cap behind the charge.

Judging of the gun, after this preliminary trial, which was conducted with the utmost care by the ordnance officers, the Hotchkiss revolving cannon takes a high rank among the most terribly effective engines of modern warfare. A battery of such guns, ably served, could hold its own against a division of the best troops in the world, because the pieces, being so easily handled, they can be turned in any direction. To resist flank attacks a lighter gun on the same plan has been built by Mr. Hotchkiss for service with cavalry, and is believed to be even more effective than the heavier piece.

MINING, METALLURGY AND MINERALOGY

Condition of Blast-Furnaces.—In *The Iron Age* for September 28th an important table is printed showing the number of furnaces in and out of blast on the 1st day of that month. We present the following summary of the information which is there published in detail:

Fuel Used.	Total number completed stacks.	Number of stacks reporting.	Number of stacks in blast.	Weekly capacity in gross tons of the stacks in blast.	Number of stacks out of blast.	Weekly capacity in gross tons of the stacks out of blast.
Charcoal	285	222	70	6,797	152	12,009
Anthracite	225	225	70	13,790	155	28,605
Bituminous	209	209	76	18,675	133	27,065
Total	719	656	216	39,262	440	67,679

Other statements have been published on the 1st of September in each of the two preceding years, and the following table will enable the reader to compare the present condition of the furnaces with their condition in 1874 and 1875:

Fuel.	In Blast.			Out of Blast.		
	1874.	1875.	1876.	1874.	1875.	1876.
Charcoal	143	109	70	63	161	152
Anthracite	122	86	70	65	121	155
Bituminous	83	89	76	98	107	133

Another table gives the percentage of the number heard from in and out of blast, and this table is perhaps the best for exact comparison:

Fuel.	In Blast.			Out of Blast.		
	1874.	1875.	1876.	1874.	1875.	1876.
Charcoal...per ct.	69	40	32	31	60	68
Anthracite "	61	42	31	39	58	69
Bituminous "	46	45	36	54	55	64

—*The Danks' Puddler* appears to be growing in favor in England. At the late meeting of the British Iron and Steel Institute, where the subject of mechanical puddling was fully discussed, several manufacturers who had introduced the Danks' plant, expressed their complete satisfaction with the results obtained.

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Utilization of Blast-Furnace Slag for the Manufacture of Glass. (Mr. Bashley Britten.) The purposes to which at various times it has been proposed to apply blast-furnace slag are strangely various, and among others are those of casting it, in imitation of stone directly into paving blocks, slabs and pipes; of coloring it and making it into decorative tiles and columns to resemble marble; of shaping it into architectural ornaments of black obsidian; of converting it into bricks; blowing it into a white wool; pulverising it into cement; and also of reducing it in water to a state of sand, in which form it has been advertised as a valuable manure. Most of these schemes have failed and been abandoned. The only use as yet found for any considerable quantity of slag is to break it up for road making, and to build rough walls and foundations where stone is scarce. By far the major part of what is produced is wholly valueless, and the iron smelter has not only to bear the cost of moving it out of the way, but frequently must purchase land on which it may be deposited.

There is no novelty in the idea of employing slag as an ingredient of glass. It has long been so used in England to some extent, but on a larger scale abroad. For perfectly white glass, such as crystal, it is obvious that slag can be of no value at all, in consequence of the amount of iron it contains, which cannot be eliminated, and would produce a green or amber color. For all glass in which a tinge of color is either needed or is not detrimental—and this includes an extremely large proportion of all that is made—a little iron does no harm; it is, in fact, often purposely introduced as an important element, for it is capable of replacing other flux, and so lessening the amount of alkali which would otherwise be required.

The ironmaster, with a different object, is always melting down precisely the same materials; he cannot produce his iron till he has first converted the gangue of his ore into glass; but he calls "cinder," and gets rid of it as best he may. The cinder is not readily recognised as glass because it looks like stone; but all glass will look like stone if cooled slowly from its liquid state. The cause of slag being so completely devitrified is that it is too rich in lime and too poor in silica. The glassmaker, however, has to buy this lime at five or six times the price of his silica or sand, while all his ingredients together cost him comparatively little more than the very large quantity of fuel he must burn in order to bring them into the melted form in which the ironmaster throws all his glass away.

The question, therefore, to be opened out is whether there may not, to a great extent at least, be a remedy for these practical anomalies. May not the manufacture of crude iron be so combined with that of glass that the latter may be produced so cheap as to render it available for many additional uses, possibly more extensive than those to which it is at present applied? The only ingredients to be bought are sixty-five tons of common yellow or red sand, to be had anywhere, at a nominal price, and ten tons of common sulphate of soda, which my be bought or made for about 20s. per ton. The necessary fuel would be limited to what is needed beyond the surplus heat of the slag to raise only 3-7th of the glass to the required heat; and it is a question whether the greater part of even this might not be saved by bringing down some of the spare gases from the blast furnace and employing them with regenerators; if needed, they could easily be enriched with a little added carbon. Against these items there would be a set-off for the cost of removing the 100 tons of slag, which must otherwise be thrown away. Besides this, another and considerable saving would arise from the wear and tear of a glass furnace being lessened, in consequence of 4-7ths of the materials going into them being already fused. Under such circumstances, the total cost of the glass in a melted state ready for working is seen to be so extremely small that it is hardly safe to venture to express it in figures; it scarcely amounts to the value of the commonest bricks per ton.

Blast-furnace works, where pig-iron only is made, frequently stand in pairs in isolated situations, with plenty of space around, on which glassworks may be erected on any scale; and, in many instances they might be built close up to the sides of the furnaces, and extended laterally away from the pig bed. In that case the slag might be run directly into a glass-furnace, on the well-known plan of Mr. Siemens, for continuous founding and working. Where there is insufficient room for this, the glassworks might be at some distance, and the slag could be collected and conveyed to them in a state of fusion in large covered ladles on wheels, similar to those used in some Bessemer steel-works, where the molten iron is carried upwards of a mile to be poured into the converters. [Abr. from *Iron* viii, 396.]

The Alleged Interior Planet.—Prof. S. P. Langley, of the Allegheny Observatory, writes to the New York *Tribune* as follows:—

In view of the public interest in the possible observation of an "intra-Mercurial planet," anticipated by M. Leverrier for October 2d or 3d, it may be well to remark that the early statements to the effect that M. Leverrier had received a letter from Wolf of Zurich, saying that on April 4th three observers—one in Germany, one in Switzerland, and one in Greece—observed the passage of a round spot across the sun, are incorrect. This would have been, if true, news indeed, for here two at least of the observers alluded to are professional astronomers, none of whom have yet in any instance, caught sight of one of these intra-Mercurial planets, which, singularly, have only been seen by amateurs, in spite of eager watching on the part of those specially interested. Now what gave the origin to this story is a communication made on the 28th of August, by M. Leverrier to the Academie des Sciences, of a letter of M. Wolf of Zurich. (M. Wolf is a reputable astronomer who has given special attention to the sun.) What he says is (translated):—"M. Weber, at Peckeloh, saw on the 4th of April last, at 4h. 25m. Berlin mean time, a round spot on the sun, which had been seen without spot the morning of the same day and of that following, not only by M. Weber, but by me and by M. Schmidt at Athens." One person then (and again an amateur apparently) saw, or thought he saw, a spot on the sun. That is all. It is not even described as moving, and the two professional observers did not see it.

A New Use for Sea Weed.—Hai-thao, or gelose, is a tasteless, odorless, colorless mass, obtained from a fibrous sea weed common on the coast of China and Mauritius. It is insoluble in cold water, but dissolves in hot water after boiling for ten minutes, and then forms a thin, dirty white solution, which on cooling, deposits a yellowish grey jelly. The material has lately been used for finishing cotton fabrics, and is reported to fill the thread more perfectly than dextrin or starch. By adding glycerin to the hai-thao solution, a still softer and at the same time stronger material is obtained. According to experiments made by Heilmann, an abstract of which is given in Dingler's *Polytechnisches Journal*, it appears that the material can only be employed for fine textures, soft and firm to the touch, and cannot be used as a substitute for dextrin or potato starch where a strong material is required. [*Sci. Am.* xxxv, 247,]

Metric System of Weights and Measures. At the late annual meeting of the American Pharmaceutical Association, a lengthy report was presented urging the advantages of the metric weights and measures, which have become the legalized standard of more than half of the civilized world, and proposing the formation of a permanent committee of three to further the introduction of the system in this country.

Enamelled Cooking Vessels.—Mr. Robert R. Tatlock, of Glasgow, has lately presented some facts of interest upon the above-named topic. The following is an abridgement of his paper.

He affirms that in some instances the milk-white porcelainous enamel, with which cast-iron cooking vessels are so commonly prepared, is of such a character as to be objectionable in the highest degree on account of the easy action upon it of acid fruits, common salt, and other ordinary dietetic substances, by means of which lead and even arsenic are dissolved out in large quantity during cooking operations. He gives analyses of three enamels, the samples being taken from three cast-iron pots made by different makers, in each of which lead or arsenic (and in two of them, both of these substances) were found, the percentage of lead being in one case as high as 25.8; and that of arsenic, 1.02.

The author believes that it is not so much on account of the presence of large proportions of lead and arsenic that the enamels are so objectionable, but because they are so highly basic in their character that they are readily acted upon by feebly acid solutions, the lead and arsenic being thereby easily dissolved out. In support of this opinion he adduces the fact that of the three enamels which he examined, a 1 per cent solution of citric acid almost instantly roughened and destroyed the glossy surface of that which was the most basic in character, and lead dissolved out to such an extent as to give immediately a dense black precipitate with sulphuretted hydrogen, while the one samples in which the ratio of the bases to silica was smaller, were less decidedly affected.

He thought that no enamel should be admitted to use unless it was totally unaffected by boiling with a 1 per cent solu-

tion of citric acid, which was a very moderate test, and gave it as his opinion that either the use of such poisonous ingredients as lead and arsenic in large quantity should be entirely discontinued, or that the composition otherwise should be of such a character as to ensure that none of the poisonous substances could be dissolved out in the circumstances under which the vessels are used. [Abr. from *Chem. News* xxxiv, 130].

The Absolute Weight of Atoms. Herr J. Annaheim, in a late communication to the *German Chemical Society of Berlin*, proposes the following experiment to demonstrate the extraordinary divisibility of matter, and to give a notion of the almost infinite smallness of the ultimate particle or atom. For his purpose he suggests the employment of highly tinctorial substances—fuchsin and cyanin.

To determine how small a quantity of coloring matter could be distinguished by the unassisted eye, the author took 0,0007 grammes of fuchsin, the chemical formula of which is $C_{20}\,H_{19}\,N_3$, H Cl; the particle in question being about 0.5 m. m. (about 1-50th of an inch) in diameter. This minute particle he dissolved in alcohol, and diluted the solution with water until it made a liter (1000 cub. centimetres). Every cubic centimetre of this solution contained, therefore, 0.000,000,7 grammes of the coloring matter. If a single drop of this solution be placed in a small reagent glass, and the latter is held obliquely against a sheet of white paper, the red coloration of the fuchsin can be distinctly appreciated by the eye, especially if, for purpose of comparison, a similar reagent glass with pure water is placed beside the former. About 35 drops of this solution make a cubic centimetre, from which it appears that the unaided eye can detect even so inconceivably minute a quantity of matter as $(\frac{0,0000007}{35})$, or 0.00000002 grammes (about three ten-millionths of a grain).

Assuming now this single drop of solution to contain but one molecule of fuchsin, and undoubtedly (it cannot contain less) contains vastly more, the absolute weight of one of the hydrogen atoms contained in the fuchsin, is determined to be 0.000000000059 grammes (about eight billionths of a grain). This quantity is found by dividing the quantity of coloring matter found in the single drop under observation, by the molecular weight of fuchsin as determined by its constitution; that is, 0.00000002÷337.5 (when 337.5 is the molecular weight in question).

The author then proceeds in a similar manner with cyanin. It is however quite unnecessary to go through with his calculations, as they are precisely analogous to the foregoing.

This method of calculation does not of course give us the real weight of the atom, but it positively demonstrates that the hydrogen atom *cannot be heavier than* eight billionths of a grain.

MISCELLANEOUS.

Communication with Central Africa. Mr. M'Kenzie's surveying expedition, which left in June for the purpose of surveying the bed of the proposed inland sea, appears to have ended in a *fiasco*. It seems to have been imperfectly provided with the usual and necessary appliances of a surveying expedition, and quarrels and secessions took place. After arriving at Cape Juby, inquiries were made for the "boccas" or supposed mouths of the inland sea, formerly occupying the depression in the Sahara known as El Juf, and several of these were found about forty miles to the north of the cape. The most likely one was the Bocca Granda, a rift in the rock-bound coast about three-quarters of a mile wide, and cut off from the Atlantic by a sand hill about 40 feet high. It was seen to extend seven or eight miles inland, bounded by cliffs on each side, but whether it expands into the famous El Juf, or, indeed, whether its bottom is below the sea-level or not, could not be ascertained. No levels were taken either there or in the depression of El Juf; in fact, the latter was never seen. The expedition returned to Grand Canary early in August, and was broken up. This is the only account that has been yet received, and it is evidently not from a friendly hand; when the leaders return we shall perhaps hear more about what seems at present a tissue of helpless mismanagement. [*Iron*, viii, 387].

Waxed Shoe Pegs (saturated with shoemakers' wax) are claimed to make shoes that are durable, impervious to water, easy to the feet, and not liable to rip in the shank.

EDITORIAL CORRESPONDENCE.

Philada. October 9th, 1876.

EDITORS POLYTECHNIC REVIEW. Gentlemen:—In the issue of your paper of 26th of August, there appeared a notice of the Centennial exhibit of the Reading Bolt and Nut Works.

There are several items in the article referred to, to which with your permission we desire to take exception.

The first paragraph we desire to notice reads "* * * * * nuts punched cold, unless they are subsequently repunched or drilled, have a ragged hole, the fibres of the iron being more or less disintegrated and broken in the process of punching, especially after the piercing punch has penetrated one-third or one-half the way through." When we commenced the manufacture of cold punched nuts some twenty-five years since, there were more or less of the fibres of the iron disintegrated in the process of punching, but after an experience of a few years in cold-punching, and by the use of improved tools, we have overcome this difficulty. We now punch holes in cold iron as smooth and as perfect as those punched in hot pressed nuts, and an examination of the holes in the nuts as made at our works will show that there are no loosened fibres, and it can be also seen that the holes are no larger one way than the other. Another paragraph reads "In cutting the threads in cold punched nuts the tap frequently loosens these broken fibres and they crumble out with the tap, and the thread is found broken and imperfect, especially in the center of the nut." We make a broad denial of this assertion in regard to the nuts made *by us*. We have tapped at our works about three tons of cold-punched nuts per day, and we are never obliged to condemn one on account of the thread falling out. Indeed, we can assure you that the threads as tapped by us are quite equal for all practicable purposes to threads chased by lathe-work. An examination of the tapped nuts at our exhibit in Machinery Hall, or of those sold by us, will convince any one of this fact. Nor do we have any complaint in this respect from any of our numerous patrons, and we should be very glad to refer any one to them for their opinion.

Another quotation reads, "In the method of punching hot-pressed nuts, the fibres of the iron around the hole in the nut are left undisturbed, and the thread when cut is found to be perfect and of the utmost strength that the iron will admit." This might lead some to conclude that the opposite of this is the truth in reference to cold-punched nuts. A few weeks since we had some tests of the relative strength of cold-punched and hot-pressed nuts made by Messrs. Richlé Bros., on their testing machine in Machinery Hall. We cut seven (7) pieces of iron and three (3) of steel with the Hoopes and Townsend thread, and placed on either end a hot pressed and cold-punched nut (properly tapped) and of one-half the standard thickness. In each test the thread of the hot-pressed nut was stripped by the rod, while that of the cold-punched nut remained firm and unbroken. The hot-pressed nuts used in these tests were made at the Reading Bolt and Nut Works. We shall be glad to show these stripped threads at our Centennial Exhibit.

We do not hesitate to say that we are prepared to give the best possible proofs that the cold-punched nuts as made by us, when properly tapped, are stronger than any hot-pressed nut made.

It is also asserted in the article alluded to, that "the holes in cold-punched nuts are not punched at right angles to the top and bottom of the nut," or, in other words, the holes in cold-punched nuts are crooked. Such is not the fact in regard to the nuts of our manufacture. There is always a slight concave and convex surface in a cold-punched nut, but the holes in the "Hoopes and Townsend" nut will be found at direct right angles, and the bearing will be found to be quite as even and perfect as that of the best hot-pressed nuts.

In punching a nut of cold iron the hole is left entirely free from any scale or crust, and there is not the least obstruction to the free cutting of the tap. In the holes of hot-pressed nuts there remains a hard and brittle scale, which soon takes off the fine cutting edge of the tap and the gauge is soon lost. We have tapped several tons of cold-punched nuts at our works with one and the same tap, without loss of gauge or permanent injury to the tap. The cold-punched nut is also more readily finished than the hot-pressed nut and the "chamfer" on the finished nuts as made by us is perfect and uniform, and is also more full and regular than the finish on a hot-pressed nut.

The views given in the article in reference to these nuts of hot or cold manufacture may be those of yourselves or oft he manufacturer himself, but in either case we thought best to notice them in this manner.

The reputation of our manufactures was brought in question, and we never lose an opportunity to defend the result of our careful attention to the production of these goods.

Our Centennial exhibit has brought us more prominently before the public, and we are looking forward to an increased consumption of cold-punched nuts of our manufacture.

Very truly,

HOOPES & TOWNSEND.

[In reply to the above, we have to say that we shall make tests of a number of hot-pressed and cold-punched nuts, made by different manufacturers, and bought from ordinary stock, of agents; and shall present the results of these tests at the earliest possible moment.—G].

INDUSTRIAL DEPARTMENT.

THE ESTEY ORGAN.

The general introduction of reed organs, perhaps as much as any other circumstance, may justly be said to have contributed materially to the wide diffusion of a taste and appreciation for music, the refining influences of which have caused it to be esteemed amongst cultivated people as a positive element in civilization. This distinction has been earned by the reed organ, not only because of its adaptability to render choice and acceptable service under almost every conceivable circumstance, but also from the fact that it has commended itself to popular favor in a shape at once attractive, and so comparatively inexpensive, as to be practically within the reach of the humbler classes. A visit to the fine Centennial Exhibit of reed organs made by the well-known firm of J. Estey & Co., of Brattleboro', Vermont, will afford to those who are interested in this subject, an idea of the perfection to which this branch of organ building has attained—an excellence, it may be added, without making invidious distinctions, to which the manufacturers just named have, by their skill and enterprise, contributed in no small degree.

A brief description of the nature of these musical instruments may not be found without interest.

A reed may be defined to be an elastic plate of metal, or of wood, attached to an opening, in such a manner that a current of air passing into the opening causes the plate to vibrate. These vibrations are propagated to the surrounding air, and make a musical sound, which is generally remarkably pure and free from harshness.

The simplest of all reed organs is the familiar mouth harmonicon, in which a thin strip or tongue of brass, or rather metal, is set in vibration by a current of air passing into an aperture to the end of which it is attached. In this case the current of air is supplied by the breath of the performer; in the reed organ proper—the Estey Cottage Organ about to be described—the air current is artificially supplied by a bellows. In both cases, it is to be observed, the reed is the essential element; but crude and imperfect as the first instrument is, the sweetness and melody of its sounds suggest to the hearer the latent possibilities that; with the help of patience, skill and ingenuity, have found expression in the last.

It is unnecessary here to enter into the numerous intricate details of manufacture, that would perhaps puzzle rather than instruct the reader; suffice it to say that, in the Estey establishment, the reed is made entirely by machinery, and before its completion passes through a series of complex and skillful operations of precision. The brass used for the reeds is made expressly for the purpose, and the excellence of its texture and quality is of the utmost importance; and again, to produce the different notes of the octaves, each reed of a single set of forty-eight must differ from its neighbor. In the high notes, for example, the tongue is delicately thin and flexible; in the bass notes it is heavier and less yielding; while a great variety of shapes and sizes are introduced to produce the tones controlled by the various stops. Finally, the finished reed, before it enters the organ in its appropriate place, must pass the ordeal of a critical examination at the hands of the tuner, whose trained ear and delicate touch detect its possible defects and correct them.

Scarcely less important than the reed itself is the reed board, which covers the reed chamber. This part of the instrument serves not only to hold the reeds in place, but to act as sounding boards. The character of the material that enters into their construction is therefore of great importance, and must be carefully selected. Having been selected and prepared, they are pierced with apertures corresponding in size to the reeds, and above these apertures are placed the valves which, controlled by the keys under the fingers of the performer, admit the air current to the reeds. The valves in question are small strips of wood covered with a soft pad, attached to one end of the aperture by means of hinged or pivoted points, and having at the other end a lever operated from the keys.

The reed board forms the top of the air chamber, which is an air-tight compartment made of pure wood, and extending from end to end of the organ. Beneath this chamber and connected with it, is the bellows, the function and mode of operating which will appear. The blow-pedals operated by the feet

of the player connect with two small bellows, which exhaust the air in the large one, forcing this in turn to exhaust the supply in the air chamber. Under these circumstances it is obvious that the instrument can only obtain a fresh supply of air by pressing upon one or more of the keys, and when this pressure is controlled by skilled fingers, the result is a sweet strain of music. The swell, which is simply indispensable in all organ music, in the Estey organ is controlled by the knee which opens a shutter in the case and allows the sound to be more distinctly heard.

The other stops, by appropriate mechanism, connect with or shut off from the air chamber, the various sets of reeds that produce different tones. The vital parts of the organ, then, are the reeds, the reed-board, the air chamber, the bellows, the valves and keys, the swell and stops. Besides these there are likewise peculiar attachments and stops, which add greatly to the effectiveness of the instrument; of these there may be mentioned the *vox humana*, the harmonic attachment, an octave coupler, which doubles the power of the instrument without increase in the number of the reeds; and the patent manual sub-bass, by which the effect of pedal bass is produced by the keys.

The same care and close scrutiny required in the selection of material and the manufacture of the instrument, it is necessary to bestow also upon the fittings—in which nothing but the most thoroughly seasoned and dried timber can be employed.

All the component parts of the instrument having been brought together and compactly arranged, the result is the Estey Organ—an acknowledged leader among this class of instruments.

So far as shape, size, power and cost are concerned, the Estey manufactory turns out instruments adapted to meet every circumstance of demand—the cottage, sitting-room, the parlor, the school-room, the vestry, the public hall or the church.

The points of merit about the organs in question, to which the makers lay a special claim, are their excellence of quality and reliability, and their comparative cheapness.

The manufactory at Brattleboro', which has grown into imposing dimensions, was established some thirty years ago by the present head of the firm; and during the last year sent out some nine thousand organs, of which a large number went abroad.

TANNERINE.

A chemical preparation designed to take the place of urine in preparing leather to receive the coloring matter.

In continuation of the frequent notices of the novelties of the great Exhibition that find place in the "REVIEW," an allusion to the above named preparation, as representing an improvement in the art of preparing and finishing leather, will be read with interest. The preparation in question is affirmed to be growing rapidly in favor with tanners and leather finishers as a thorough cleanser of leather preparatory to applying the oil blacking or colors, and is pronounced to be an efficacious cleanser of bridles, harness, etc., removing all marks of grease, or stains, in less time and with far less inconvenience than attends the use of soap. From the results of tests made with this substance in actual practice, as gleaned from apparently thoroughly trustworthy sources, it would appear to have established the manufacturer's claims, that a small quantity of the tannerine applied to the flesh or grain side of leather renders the same soft and flexible, and gives greater permanency and brilliancy to colors than can be obtained by the old process of employing urine; the new process being at the same time more rapid in action than the old, quite free from offensive odor, and not in the least injurious to the grain. In substantiation of these statements, it will suffice to append a brief abstract of the results of numerous experimental trials of tannerine that are at hand.

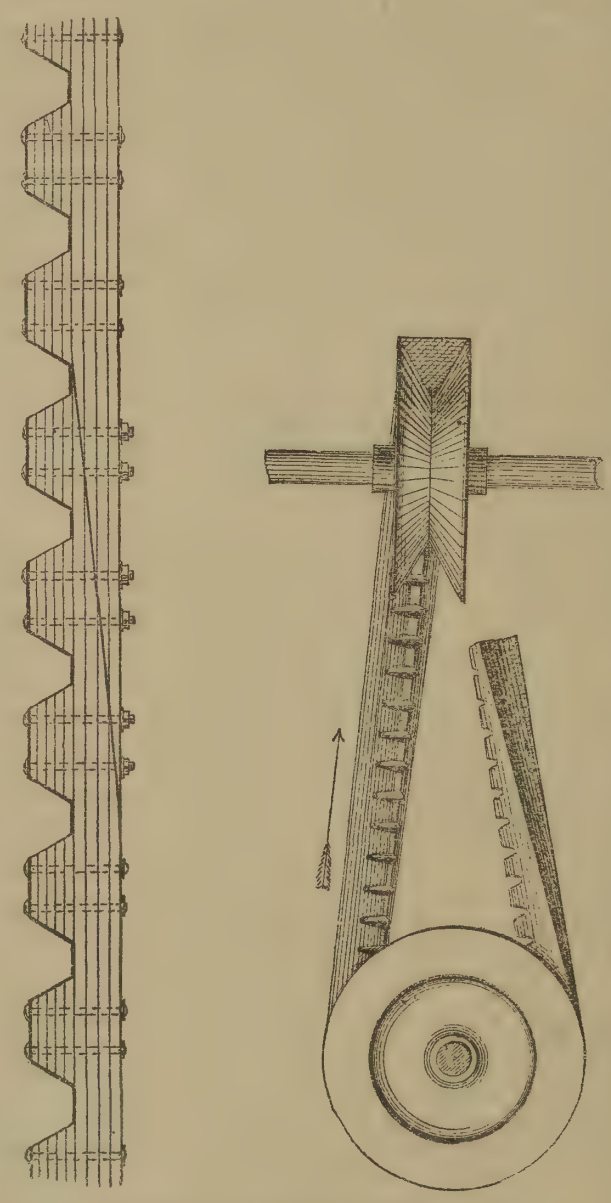
From one source, New Lisbon, N Y., for example, the statement is made and vouched for, that the application of tannerine on the grain side of leather for the coloring, gave excellent results, producing a color of great brilliancy and permanency, and leaving the leather very pliant. The experimenter in question expresses the conviction that tannerine will answer another valuable purpose in finishing leather, namely: as an application, in connection with copperas solution, previous to putting on oil blacking. This report closes with the following handsome approval. "There seems to be, first, the right amount of chemical ingredients (in the tannerine) to neutralize the grease and other foreign substances (of the leather), and exactly the requisite quantity of the other constituents to absorb and hold these impurities, so that when the preparation is removed, the surface of the leather is ready for the color." A second report (from A. Beers, of Laurens, N. Y.), affords the statement that "If the preparations used for coloring are good, the colors take more immediately, are perfectly indelible, and the leather is more easily prepared, by the application of the tannerine, to receive its color."

The Messrs. Pierson of Philadelphia endorse the claims of the manufacturers and add the following additional testimonial to the value of tannerine for the uses for which it is claimed to be adapted, viz:

"We were induced to try it on the 'merino skin,' well-known to all in the trade to be one of the hardest things to clean and most difficult to blacken, and accordingly had one of the roughest skins out of a very inferior lot of these subjected to this process, and we were very agreeably surprised, on finishing, to find it come out a fine jet black instead of a sickly blue tinge, as has generally been the case heretofore with a low grade of this skin treated under the old process,"

Aside from its merits as a cleanser of leather during the process of its preparation to receive the coloring, tannerine is affirmed to be well adapted for cleansing harness and carriage leather, the cloth trimmings and glass of carriages, and the like, as well as for enamelled leather, morocco, and metallic articles generally. In using it for this purpore, a small quantity of the powder is dissolved in clean water, and applied to the articles to be cleansed by means of a rag, the surfaces being subsequently dried by the use of a cotton cloth.

The preparation above described is made by the Centennial Manufacturing Co., 109 Walnut Street, Philadelphia, where samples of the same may be obtained by interested parties, and various articles illustrating its applications may be inspected. An exhibit illustrative of the uses of tannerine may also be seen in the Shoe and Leather Building of the Exhibition.



ANGULAR OR "V" BELTING.

The problem of perfect transmission of power has had many attempts at solution. The communication of motion by wrapping connectors, where the directional relation and velocity-ratio are constant, is effected by bands of various materials and shapes. Catgut cords, hempen and wire ropes, plaited rope, chains of various shapes,* flat and round belts of rubber, flat leather bands, twisted and plaited leather cords, etc., are in common use, and are more or less familiar.

As the motion communicated by such means is smooth, powerful, and generally noiseless, it is the most commonly employed system, where it is not essential that the revolutions transmitted should be transferred in an exact ratio of time. Where this last is a requisite, as in horology, etc., the system is unavailable.

* It might be questioned whether, strictly speaking, a chain working in a sprocket wheel is not really a continuous and revolving *rack*, and not classifiable under the same heading as belts.

The principal disadvantage in this mode of transmitting motion is that as its success is entirely dependent upon the amount of friction between the belt and the pulleys, either the power is intermittent in action and decreased in amount, through slipping, or the system is subjected to unusual wear and tear in the effort to create and maintain a high degree of friction. Flat bands slip even where (as is very seldom the case) there is full contact between strap and pulley. A round belt running in a wedge-shaped groove need have less diameter, and has more frictional surface, than a flat belt running on a flat or crowning pulley; but as its friction is in reality due to a constant wedging and releasing, it is evident that the walls of the groove are not fully available for this wedging contact, to obtain a minimum of which, the belt should in sections be an acute trapezium, with its wedging sides of the same angle of convergence as, and parallel with, the wedging walls of the V-grooved pulley. Such a belt would be heavy, and would be so lacking in that *flexibility* which is equally essential with a high co-efficient of friction, as to refuse to conform to the periphery of pulleys of small diameter.

Two conditions must be met. (1) The gripping portions of the length of the belt, while on either pulley face, must have the inner or narrower face enough shorter than the back to allow each to follow its curve of revolution without undue compression or extension of any portion, whatever its distance from the pulley center. (2) The free portions of the belt, lying between the points of tangency, and transmitting the power in straight lines only, must have their inner and outer faces of *equal* length.

There is but one solution to this problem—to divide the belt into two parts, each with a distinct object—an outer, or transmitting portion, and an inner, or gripping portion, capable of ready flexion, and with a marked *wedging* capacity. To accomplish this, the inner portion must be so "kerfed" by the removal of wedges or truncated pyramids,† as to fill the pulley groove. The outer or transmitting section of the belt must be of sufficient tensile strength to convey the power without rupture or strain. Such a belt is illustrated in the accompanying cuts, and is shown at the Centennial by Messrs. Chatfield, Underwood & Co., of 29 Ferry Street, New York. In Machinery Hall it may be seen at Column D 9, sec. 65; and is driving the great centrifugal pump in the Hydraulic Annex.

It is made of truncated "wedging" pyramids of leather of many plies, cemented and riveted together; the whole being strongly riveted to a conveying strap of leather.

Its makers claim for it flexibility, strength, a high gripping power, great durability, and low first cost.

† The acuteness of the removed wedges or truncated pyramids and of those truncated pyramids which remain for gripping action, is directly proportional to the diameter of the pulley as compared wit the depth of the belt.

THE "DEXTER" CARRIAGE SPRING.

There are two advantages in a *good* spring—when you get it. It makes the riding pleasant, and don't break up your carriage. In the device illustrated herewith,* a perfect spring is secured by taking *two* "Concord," or side springs, at each side; placing one above the other and parallel to it; rigidly attaching each pair to each other, at their centres, and pivoting their ends to spring links above (or on either side of axle and spring-bar.) The spring links are rigidly attached to the head-block and rear axle respectively.

By the parallel motion of the springs, *rocking* of the axles is prevented. One spring being above the other, prevents side motion or settling of the body to one side. There is no reach; hence any one wheel may pass over an obstruction almost independently of the other wheels—especially in rapid driving. By the great ease and elasticity of the springs, the "fifth wheel" is greatly relieved—and so is the driver.

The wheels need no extra braces to keep them in track, since every strain tending to *un*-track them, comes upon the slotted frame (or body) *diagonally* to its length.

With this spring, a light load may be carried easily; while it will bear and carry an *over*-load better than any other known.

Instead of the slotted frame, a calache top may be used without any fears of its being clattered to pieces.

The Dexter Spring Co., of Hulton, Alleghany Co., Pa., makes these springs at its own works (now running on full time.) The best cast steel is used in first-class springs, and warranted the best in the market; a very superior quality of malleable iron, better than ordinary wrought iron, is used.

The spring may be seen about the centre of the American Department of carriages; also in Machinery Hall, at D, 79. The same company also manufactures a Hydraulic Ram and Sentinel,

A Buck wagon and a top and no top piano wagon may be seen in the south-west corner of the carriage building at Centennial Exposition.

* See advertisement, fourth cover page.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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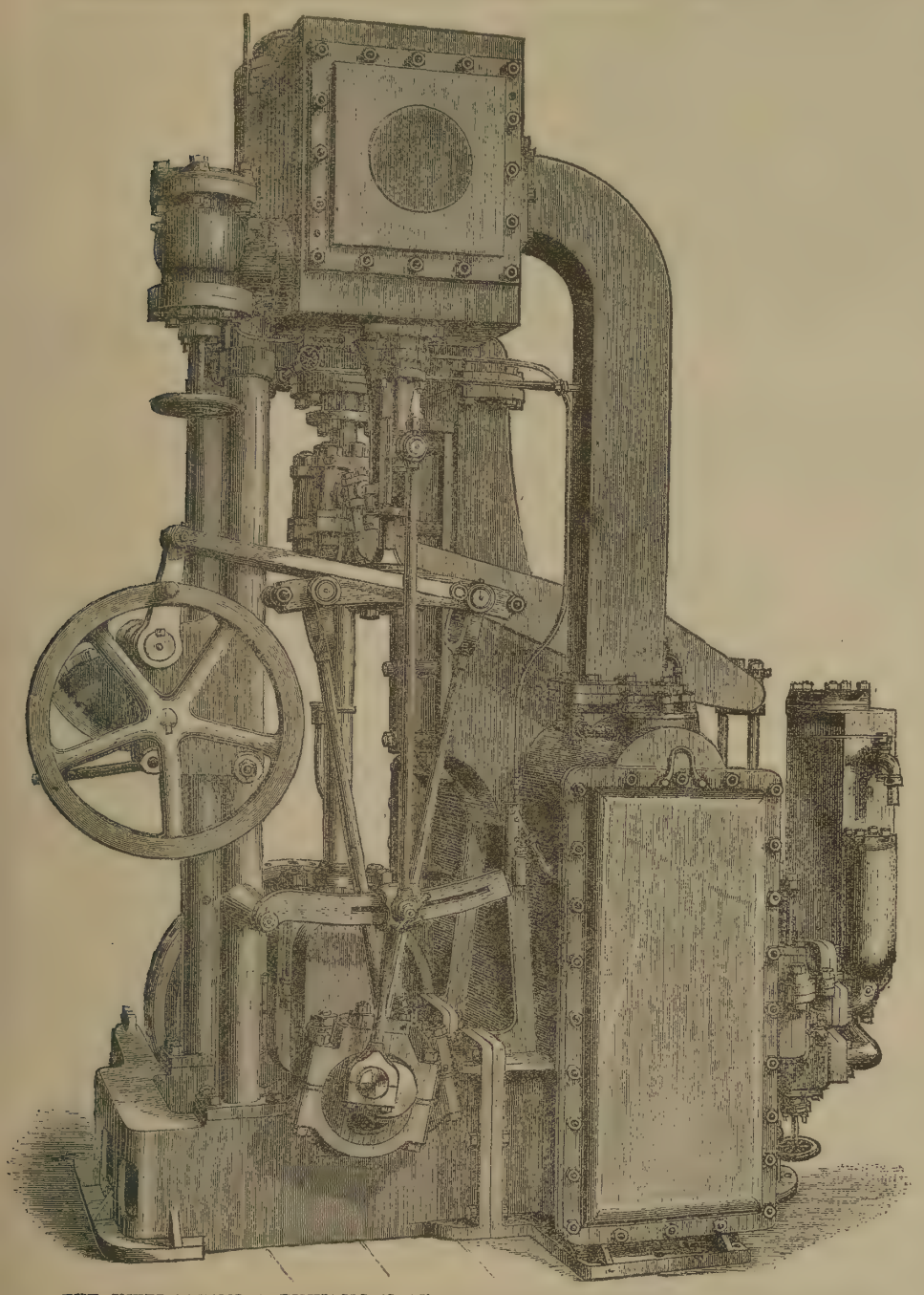


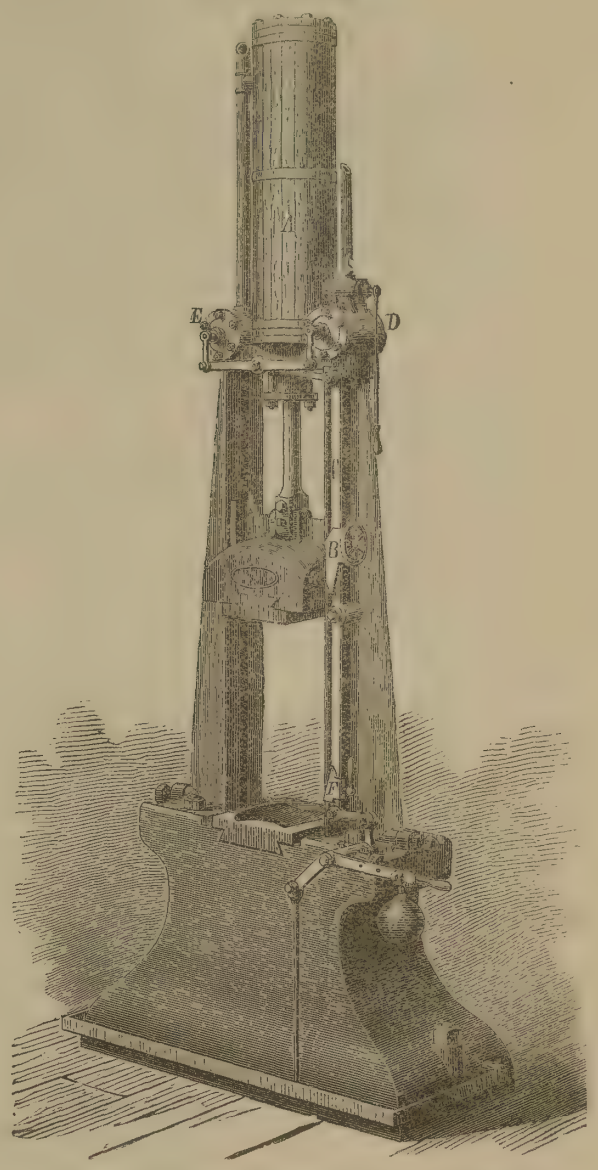
THE INTERNATIONAL EXHIBITION OF 1876.—MARINE ENGINE, BY CRAMP & SONS.

SINGLE-CYLINDER MARINE ENGINE.*

Among the comparatively few exhibits of marine engines at the Centennial, those of Messrs. William Cramp and Sons, of Philadelphia, occupy a prominent place. We illustrate herewith the smallest of their exhibits, a single cylinder, high pressure, surface condensing engine. This class of engine has been largely introduced upon tug-boats running on the Delaware and other rivers, where paddle-wheels are generally abandoned for screws on towing boats. As shown in the engraving, the point of cut-off is controlled by altering the stroke of the expansion valve. It will be seen that the lower end of the expansion valve spindle terminates in a cross-head, working in guides. On the side of the cross-head is a pin on which is placed a link which descends as far as an oscillating segmental arm attached at one end to one of the main pillars forming the framing of the engine. To this arm, which is graduated, is attached the upper end of the link to which motion is given by a crank on the main shaft, as shown. The lower end of the link descending from the cross-head of the expansion valve spindle, slides upon the graduated arm, and may he locked in any desired position by means of the screw and handle shown; and by sliding it to and fro, any desired degree of expansion may be obtained. The reversing gear consists of a hand-wheel, carrying a pinion on its shaft which gears into a segment with internal teeth, and throws the lever attached to the link to and fro. The air pump is worked in the ordinary way by back levers connected with the cross-head, which latter works on a slipper guide upon the main frame.

The diameter of cylinder of this engine is 20 in., and the length of stroke 22 in. With 59 lb. initial pressure in the cylinder, and a speed of 100 revolutions per minute, an indicated horse-power of 196 was developed on trial. [*Engineering*, xxi, 479.]

* [The illustration is photo-engraved from *Engineering*. EDS.]



DIRECT ACTING STEAM DROP HAMMER.

(HILL & WILLIAMS, QUINCY, ILL.)

The illustration represents the position the hammer assumes after opening the throttle valve.

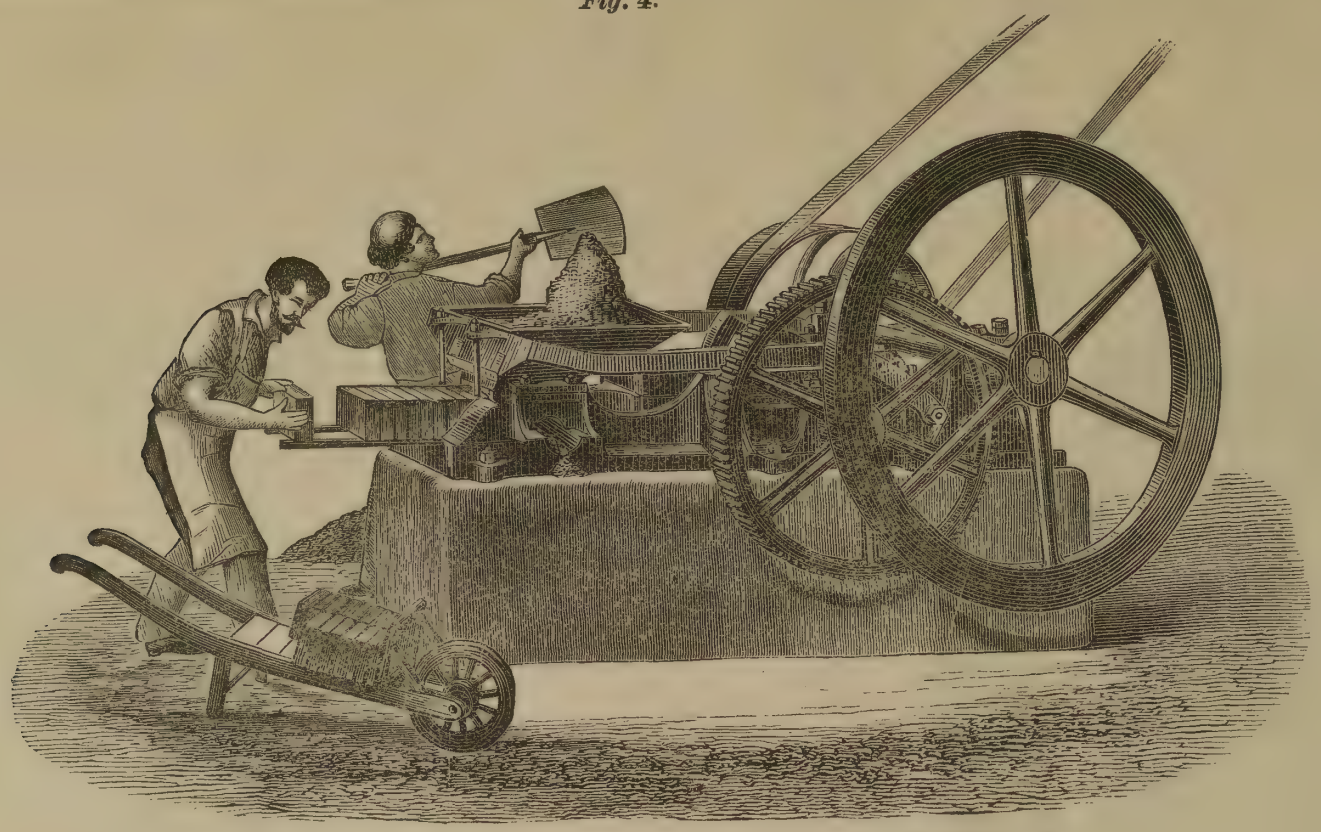
To drop the hammer the operator presses the treadle; this opens the exhaust valve E, through the medium of the pivoted bar C, connecting to both valves, allowing the steam in cylinder A to escape. The hammer will then fall until it reaches the end of its stroke, or until the foot of the operator is raised from the treadle, which causes the exhaust valve E to close and the receiving valve D to open. The hammer will now ascend until the stud on the hammer-head strikes the upper adjustable dog B; this causes the receiving valve to close—the exhaust still remaining closed, holding the hammer suspended by the steam in cylinder, in which position it remains until the treadle is again depressed by the foot of the operator. An adjustment of the dog B gives any length of blow desired from a state of rest. The operator can cause the hammer to fall at any time during its ascent by depressing the treadle; or arrest it at any time during its descent, by raising the foot from the treadle; thus enabling light or heavy blows to be given in rapid succession.

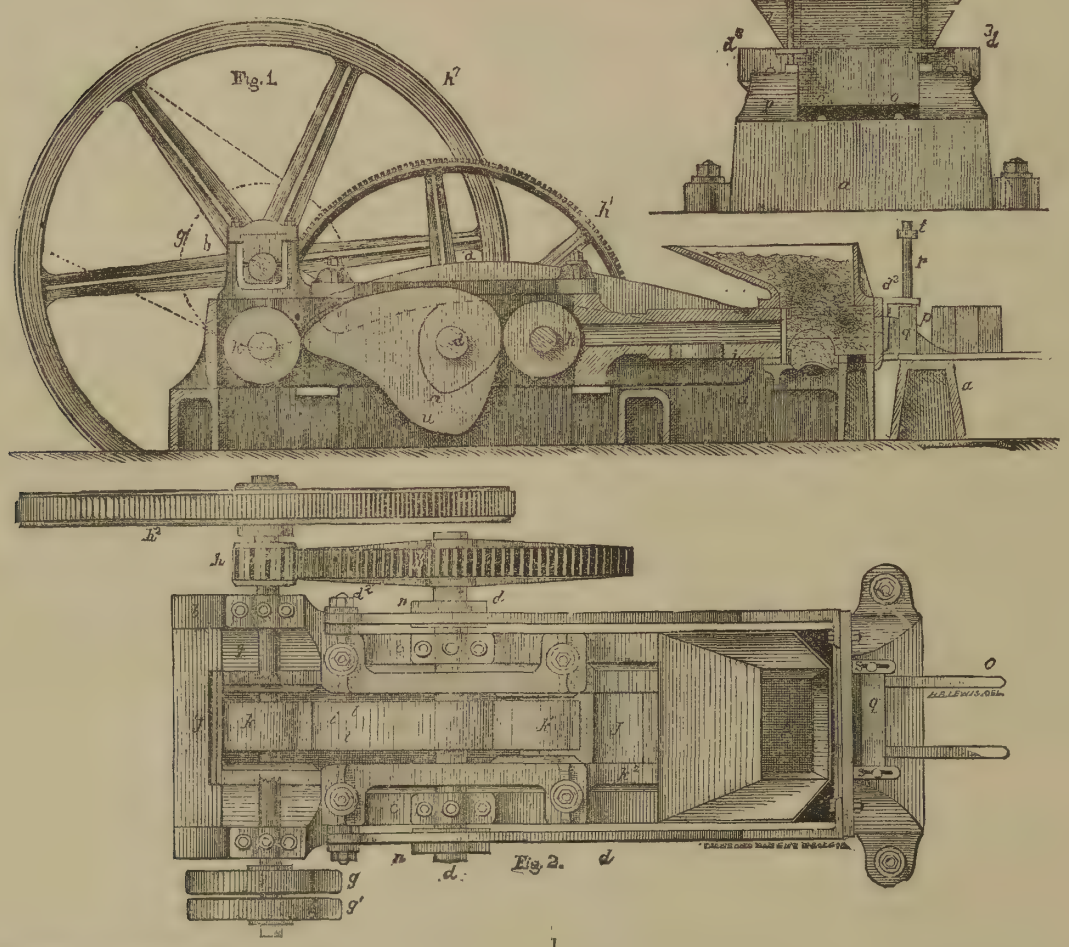
The valves are balanced. The joints are all ground; the piston rod is made of steel. It is not complicated in its arrangement, and should not be likely to get out of order. It need not require the attention of a skilled mechanic to operate it, and its management should be learned in a very short time.

The machines are made to lift double the weight of hammer on 50 pounds of steam. A die equal in weight to the hammer can therefore be used at that pressure.

THE SUBSCRIPTION DEPARTMENT of the POLYTECHNIC REVIEW is being pushed with great energy and intelligence, and the commencement of our third volume, in January next, will find us offering to advertisers opportunities which will be unexcelled if not unequalled.

Fig. 4.





THE DURAND & MARAIS BRICK MACHINE.

(FRENCH SECTION, MACHINERY HALL.)

The apparatus herewith illustrated is one which received a gold medal at the Paris International Exposition, of 1875; and which, by its strength and simplicity, commends itself for the manufacture of bricks, and blocks of agglomerates of any nature—such as compressed fuel, etc.

Fig. 1 represents a longitudinal vertical section of the machine; Fig. 2, a plan; Fig. 3, an elevation of the end at which the bricks are delivered; Fig. 4,* a general view.

The machine has a cast-iron base, a, a; this has four pillow blocks, b, b, c, c, carrying two parallel shafts, d, f. The shaft carries the fast and loose pulleys, and the pinion, h, which gears with the spur-wheel, h^2, on the shaft, d. The shaft, f, carries also a fly-wheel, h^2. The shaft, d, actuated by the spur-wheel, h, bears three cams; the principal cam, i, fixed in the middle of the shaft, moves the compressing piston. The form of this cam is so determined as to effect excessively—(1) the compression of the material to be agglomerated; (2) a very powerful "re-pressure" of short duration; and (3) the expulsion of the finished brick or block.

This cam acts on the piston, j, by means of two rollers, k, k, which are mounted in a cage forming an extension of the piston. The two exterior cams, n, n, act simultaneously upon two levers, d, d^1, fulcrumed on the base at the points, d^2; the two other extremities of these levers are strongly bolted to a plate, d^3, which serves to close the mould, and which, by its rising, opens the port for the issue of the brick or block.

The clay, or material to be agglomerated, is thrown into the hopper above the piston, j. It is molded in A by the piston, and then expelled from the machine after the lifting of the plate, d^3; and the products are pushed forward in the bars, o, whence they are taken away.

There is an opening in the compressing piston, so as to permit the escape of surplus material, and to render the pressure equal in all parts. The block, as it issues from the mould, rests on a plate, g, which, by a slight up and down movement, detaches it from the extremity of the piston.

The principal difficulty in brick-making by machinery, is the equal filling of the moulds. In this machine, the material falls in excess into the mould, which is designed to retain only the absolute quantity necessary to complete accurate moulding. The hole in the centre of the piston-head is designed to carry away any excess, and to allow the piston to distribute the pressure into the angles, so that the agglomerate shall issue from the mould sharp, hard, and regular.

All the movements of the machine are slow and positive; the parts are strong and the result very thoroughly compressed. The guaranteed product is 8,000 to 10,000 bricks per day of ten hours; using one horse-power. The machine occupies a floor-space of 7 by 3½ feet, weighs 3500 lbs., and costs $800.

Machines of this class are much employed in the manufacture of compressed fuel; and in France and Cuba, for compressing the sugar as it issues from the vats, into tablets like those of chocolate, the panels of which can be readily broken apart. One of the Durand machines is being made by R. S. Newbold & Son, of Norristown, Pa., for the "Imperishable Block Co.," and is designed to make paving blocks 12×4×5 inches in size.

* [Given by courtesy of *Aurora Brazileira*.]

NITRO-GLYCERINE.

II.

The manner in which nitro-glycerine was first brought to public knowledge in this country will long be remembered. A terrible explosion occurred in 1865 in Greenwich street, New York, by which the windows of every house within one hundred yards of the *locus* of the explosion were shattered, pedestrians were thrown down, and the pavement broken up. An investigation subsequently brought to light the fact that the explosion was caused by a box containing nitro-glycerine, which had been thrown into the street by a person ignorant of its nature. The box proved afterwards to have been left behind by a person intrusted with an agency for introducing the explosive to miners, by the Nobel Bros., who had a manufactory in Hamburg, where it was made. The following year, the substance was again brought to public notice by an explosion occurring on the steamer *European*, at the railway wharf of Aspinwall, which involved not only the total destruction of this vessel, but the loss likewise of forty-seven lives. Immediately upon the heels of this calamity came an explosion in the office of Wells, Fargo & Co., in San Francisco, by which eight persons were killed, and property to the value of a quarter of a million dollars was destroyed.

With such an introduction, therefore, it is not surprising that the public estimate of this powerful explosive was highly unfavorable. When all the circumstances attending these disasters were fully considered, they indicated very clearly that the accidents resulted rather from inexperience in the manufacture of the explosive, and from ignorance of the proper methods of transporting and handling it, than from any necessary instability of the material itself. This opinion was subsequently abundantly verified, since it has been shown that for some years after its first introduction, the nitro-glycerine of commerce was quite impure; and inasmuch as the instability of this substance, or its tendency to decompose spontaneously, has been proved to be practically directly proportional to the degree of its impurity, the unfortunate circumstances attending its introduction are susceptible of a rational explanation. Some years ago, the writer, in a brief article upon this subject, presented certain opinions, which appear to be so *apropos* in this connection, that they are herewith reproduced, viz: "The prevailing popular opinion concerning the substance known as nitro-glycerine, endows it not only with amazing explosive energy, but likewise with the possession of unknown or mysterious properties, which render it liable at any moment, and from quite unexpected and non-avertible causes, to give rise to the most frightful accidents. This opinion may have had ground for its justification years ago, when this valuable product was first employed in the useful arts, at which time, through ignorance of its qualities, it was the cause of several terrible misfortunes, attended with great loss of life, and which appears to have acquired for it a reputation for being an unmanageable as well as powerful explosive, that has unjustly clung to it ever since."

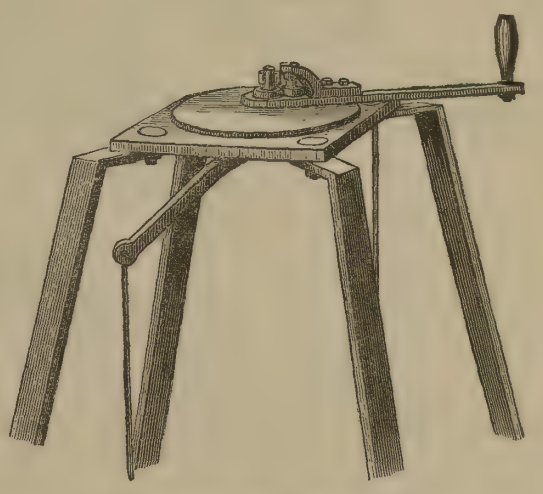
Of late, however, the use of nitro-glycerine has increased to an extraordinary extent, until at the present time no tunneling or excavating work of magnitude is undertaken without its aid. Indeed, it may be said that without it many recent engineering projects would never have been undertaken at all; while the completion of others, the Mont Cenis and Hoosac Tunnels, the Hell Gate improvements, etc., has been wonderfully hastened by its unrivalled power as an explosive. Its properties have been carefully studied and mastered, its manufacture has been improved, and the proper modes of its use and handling so clearly defined, that the percentage of accidents attendant upon its employment will compare favorably with that incident to the use of gunpowder for similar purposes. As one of the results of the growing familiarity with this substance, one fact of great importance was very early established, namely, that while the pure article was practically safe, in manufacture, transport, or storage, the spontaneous explosion of an impure product is simply a question of time and temperature—a fact that goes far to explain the alarming frequency of accidents attending, at first, the introduction of the material.

The introduction of numerous substantial improvements in the manufacture of this, now indispensable, agent, and the determination of the conditions of its safe employment, have been brought about largely through the indefatigable labors and scientific skill of one man, George M. Mowbray, who stands confessedly at the head of nitro-glycerine manufacturers in this country. Mr. Mowbray's operations as a manufacturer of nitro-glycerine were commenced at North Adams, Mass., in the winter of 1867-68, under a contract with the Hoosac Tunnel Commission, and the degree of success which he has met with is best evidenced by the fact that he has, during that time, produced over 1,000,000 lbs. of this terrible explosive, and this with only two accidents, both of which were caused by gross carelessness and violation of orders on the part of workmen.

By way of explanation, it may be remarked that nitro-glycerine is manufactured by adding chemically pure glycerine, very gradually, to a cold mixture of strong nitric and sulphuric acids, in the proportions of about ½ lb. of glycerine to a mixture of 1 lb. of nitric and 2 lbs. of sulphuric acid. We shall shortly be able to give an illustrated description of the whole process of this manufacture, which involves many points of interest. For the present it must suffice to remark that during the whole process the utmost care and watchfulness is required. One of the most valuable observations, which Mr. Mowbray made early in the history of his connection with the nitro-glycerine industry, is the fact that the value and stability of the explosive is largely dependent on the purity of the materials employed in its manufacture. Upon this point the greatest attention is bestowed; the glycerine is carefully purified, and the acids employed are manufactured on the premises, and are in their most concentrated form. A decided improvement introduced by Mr. Mowbray is his method of keeping the acid mixture cool, while the glycerine is being added. This operation, which is a prime element of safety, since the heating of the mixture in the process of manufacture is attended with imminent danger, Mr. Mowbray performs, simply and effectually, by blowing through the mixture a current of cold air. The tri-nitro-glycerine, as the resulting compound is called, has come to be very generally, and no doubt justly, known as the safest, as well as the purest and strongest now in commerce. This excellence of quality, as we have endeavored to show, is doubtless largely contributed to by the intelligent care bestowed upon every step and element of the manufacture; notably in having the glycerine perfectly pure and dry, in having the acid mixture thoroughly cooled when the glycerine is run into it, and in the attention bestowed in purifying the finished product, which occupies some 72 hours, and its crystallization 48 hours more. Just here we may note one peculiar advantage which the Mowbray method of using the cold air current possesses over all other methods employed—it is this. The cold air not only keeps the temperature of the mixture down, avoiding the greatly-to-be-feared danger of heating, but it effectually removes, by oxidation, the low oxidation products of nitrogen that are always formed during this operation—such as nitrous and hyponitric acids. It is highly probable, as chemists have strongly suspected, that the tendency of nitro-glycerine to spontaneous decomposition and explosion, is materially brought about by the presence of these lower oxidation products just named, and their effectual removal, which Mowbray accomplishes, contributes perhaps more than anything else to the superior qualities which his product is generally admitted to possess. His product is an oily liquid, having a specific gravity of 1.6 (at 60° Fahr.), and is distinguished from all other nitro-glycerine by being entirely colorless. It is free from odor, is insoluble in water, but soluble in alcohol and ether. It has an aromatic taste, but the smallest quantity placed upon the tongue causes a severe though transient headache. After complete purification, the product is run into square tin cans holding 56 lbs. These are packed for 48 hours in ice, until it solidifies, and, packed in a box with sponge upon the bottom, resting upon rubber tubes which come up over the cans, and well-iced, it may be transported with comparative safety—or, as Mr. Mowbray very suggestively says, "as safely as so many tubs of butter."

W.

(To be continued.)



HOOK AND EYE BENDER.

The above cut represents a valuable little machine made by Hill & Williams, Quincy, Illinois. With this it is claimed that a boy can bend, in one hour, more hooks or eyes, for agricultural implements, than a blacksmith can make in a day, and that they will be perfect and of a uniform size, and free from hammer marks. The capacity of the machine is limited only by the heating of the iron.

The heated iron being placed between the jaws, as shown in the engraving, the foot is then placed on the treadle, and at the same time the handle is brought around to the stop; and the eye is thus made very speedily.

WATER METERS.

II.

A very important distinction which should be made by the general public, but which seems thus far to have escaped recognition, should be right here laid down with emphasis—for upon it, to a great extent, hinges the question of the adoption of water meters. We believe that even those who are most willing to admit the desirability of the introduction of water meters, seem to doubt its possibility, or its kindness to certain classes. "Water," says Quilibet, "is one of God's own gifts. Water should be free as air, than which it is no less necessary to our existence, health and comfort." Granted. And so to a certain extent are all God's gifts. Like air, so water, and timber, and stone, and fruit, and fish, are most assuredly to be had for the getting, if man will only go far enough and secure them without interfering with another's convenience and store, and will only carry them where he wants them. But the wildest communist who ever insisted that the earth was the Lord's, and the fulness thereof, and that therefore tangible blessings should be free for the getting, would scarcely claim the right to free transportation of his salmon and sand-stone, and hemlock, and the rest of them. He must e'en lug his fish home himself, and hire men for the quarrying and hewing, and teams for the hauling of "his share" of the building material; and if "his share" or "his claim" be tenfold larger than his less needful or wantful neighbor's, then must his outlay for getting and transporting be proportionate.

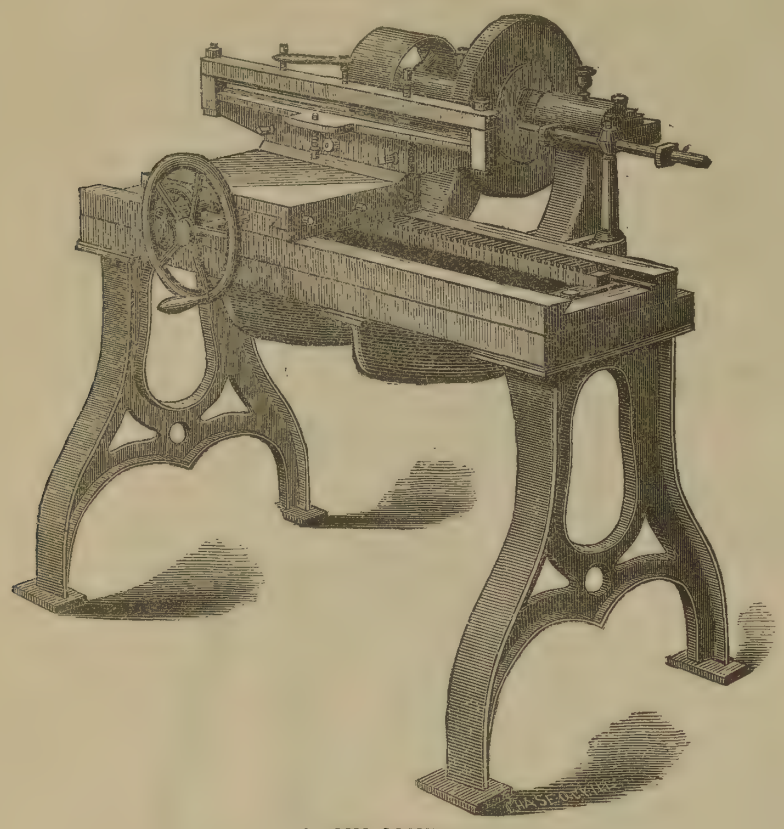
And so with water. It *is* free as air or timber; and no one thinks of charging for it, *per se*. But water-rates—whether they be paid to the Oriental "drawer of water" who carries it in leathern sack and on sturdy shoulders, or to the Occidental corporation, with Worthington pumps and six-foot mains—are charges merely for getting the water and carrying it for miles to one's very door, and even into those *sancta sanctorum*, one's bath-room and bed-chamber.

Assuredly, then, he should have most freight to pay, who has most freight carried; and all prating about the injustice or unkindness of *pro rata* charges, is idle and illogical.

But there is a further point to urge in favor of the meter system, and that a most important one; touching, not the heart-strings, but those vibrating more strongly,

and yet from less disturbing influences—the strings of the purse. If it can be shown that by the general introduction of meters, there is not only the possibility, but a very strong *probability*, of a lessening of water-rates, even under an increased permission of useful consumption of water—then but one thing remains—to show that there are, or can be made, cheap, durable, and non-tamperable meters, capable of registering correctly under all conditions of quantity, quality, and pressure of water.

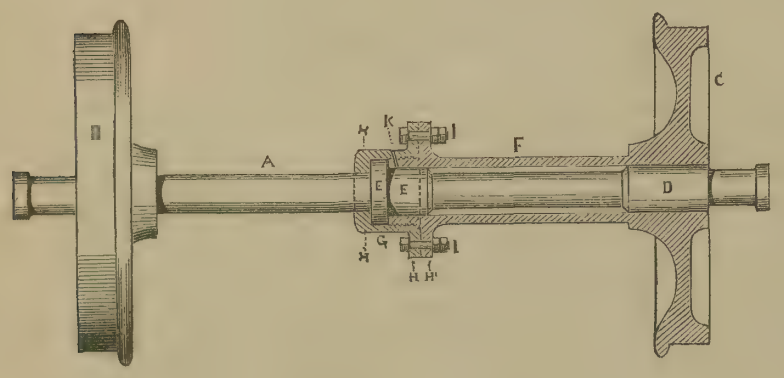
In our next article we will discuss the question of the *pro rata* system in its aspects as a probable lessener of water-rates, under freer useful consumption than is now permitted us. G.



PLOW JOINTER.

(HILL & WILLIAMS, QUINCY, ILL.)

The ambition of plow makers to manufacture a perfect and uniform plow, both in form and finish, has created a demand for special machinery to facilitate, and at the same time reduce the cost of labor. An efficient machine is represented in the above cut. It is claimed that with it all those joints can be made to fit accurately by a common laboring hand, which formerly required skilled labor at high wages. The mould board, or shear, is placed in the jaws, as seen in the engraving, and secured by the set screws, and is then moved laterally and fed transversely against the emery wheel until a perfectly square edge is obtained. By this means the mould board and shear of a plow can be made to fit as closely as if made of one piece of metal.



HARRISON'S CAR AXLE.

Our railroad engineers have the reputation of being among the most practical, inventive, and economical of men; and yet, in one or two particulars, they are either unmindful of, or unable to counteract, a very important waste of power, money, and comfort. Perhaps not the least important of these particulars is the usage in respect to rigidly paired wheels. There may be some points of advantage as regards the journalling of the ordinary rigid axle and pair of wheels; but how markedly these advantages are over-balanced by the wear and tear of wheels, journals, and rails; the waste of time and fuel; and the many accidents occurring through the use of the rigid attachment system. The fact that the outside rail on a curve is longer than the inside, necessitates that one wheel must slip or skid; no "end-play" or arrangement of boxes fully meeting this difficulty. There are two ways of permitting of the easy rounding of short curves, without slipping or skidding. One of these ways is the use of a single wheel, as in many special railroads in mountainous regions. By this mode the sharpest curve may be rounded with that facility observable in the running of an ordinary wheelbarrow.

The other alternative is to allow each wheel to revolve independently of the other, as in the common carriage; permitting of being turned in curves of any radius—indeed, the point of contact of the inner wheel may be the centre around which the outer describes a circle whose radius is the axle of the pair.

As the use of a single rail is under ordinary circumstances inadmissible, we must accept the necessity of the double rails, and permit to each wheel of our pair, free and independent action.

The device under present consideration has for its object the permission of this free and independent action, without material deviation from the ordinary construction; and furthermore, is designed to be convertible from the rigid system.

A brief mechanical description of this device, with reference to the cut given herewith, will best precede a summary of the advantages aimed at.

The difference between the new system and the old may best be described by a statement of the process of changing the old stock to the Harrison patent. To effect this, one wheel is pressed off; a female screw cap X with flange is made and slipped on the axle. In the centre of the axle is a strong shoulder E and also a long bearing E. On the end of the axle, where the wheel is off, is another long bearing D. The wheel C that has been taken off is bored out to receive a lap-welded wrought-iron tube F, with a male screw and flange to correspond with the cap before mentioned. The axle is passed into the sleeve to the shoulder; then the screw cap and flange from the other side of the shoulder is firmly secured on the sleeve. The flanges fitting tightly together are trebly bolted, doubly nutted, and keyed.

The advantages claimed for independent wheels, consequent on their property of lessening the friction incident to curves, and to inequalities in the track or wheels, are, (1) A reduction in the power required to haul the train. (2) Increased durability. (3) Saving of wear on the road-bed, especially on curves. (4) Increased comfort to passengers, consequent on the absence of oscillation on curves. (5) Economy in lubrication. (6) Freedom from hot boxes. (7) Diminished expense for repairs. (8) Safety. (9) The ability to use wheels of larger diameter than by the old system. G.

TURBINE WHEELS AT THE CENTENNIAL EXHIBITION.

II. THE ALCOTT TURBINE.

[MANUFACTURED BY T. C. ALCOTT & SON, MT. HOLLY, N. J.]

In this turbine, the wheel itself is made in one casting, with water ways in such form as to give a downward turn to the water, in passing, for the purpose of freeing the wheel of dead water. To this end, the central conoid, forming the inner and upper limits to the water passages, may have been brought down so far as to be laid open to criticism for constricting the exit area from wheel; though whatever opinion may be entertained as regards this, it is evident the wheel will clear itself well. This downward turn given to the water tends to raise the wheel from the step, relieving it from weight.

But the chief peculiarities pertain to the guides and chutes; together with the shielding of the gate-suspending and operating mechanism under the cover or dome of the wheel case. A central sleeve projects down from the under side of cover, serving as an axle for the spider from which the gate ring is suspended. This guides the ring, preventing its being thrust laterally against the chute-case by action of the operating rack-pinion, and preventing undue friction. Also, the spider regulates the height of the ring, so that it may be adjusted vertically to the proper position. By thus bringing the parts concerned in operating the

gate under cover, we secure the important advantage of protecting them from obstructing gravel and rubbish. As in the Eclipse wheel, so in this, the gate helps to form the guides, by openings in a ring which are brought opposite openings in the outer case. These openings are given the desired angle for delivering the water. In these respects the wheels are similar; but in the latter, the openings in the case and gate ring are so arranged as to open in sets of three, at different points, usually five, around the wheel. This arrangement is secured by making the space between ports wider after each three. At one position of gate all ports are fully open, at another two only, of each three, and at another only one of each set fully open. In this way the best, or full gate, conditions are realized for fractional gates, and when it is observed that, in going from full gate to a third gate, most wheels fall, in percentage, from three-fourths to one-half, the advantages of this arrangement are apparent. Furthermore, for either of these one, two, or three-third gates, the openings may be graduated at pleasure, by hand or governor, as inany other wheel.

Such a turbine is especially adapted for work which is likely to be much greater for certain periods than at others, as in grinding mills, etc., where the wheel may be required, some days, for only partial duty. An index is placed on the floor, at the gate, to show exactly how the gate stands at any moment.

In this turbine the hub of the wheel is formed into the bearing for the step, instead of the shaft; this furnishes a cast-iron bearing surface, claimed to be superior to wrought iron as regards corrosion and abrasion.

The working parts are well under cover, and shielded from sticks, sand, &c.

S. W. Robinson.

Dep't of Mech. Eng., Illinois Industrial University.

(*To be continued.*)

MODERN FIRE ENGINES.

VIII.

Pending the preparation of some engravings, the regular course of the descriptive matter on this subject is intermitted by the introduction of some historical points of interest, relative to the early record of steam fire engines abroad.

Their Early Record Abroad.—The first steam fire engine was built in London, in 1829, by Braithwaite & Ericsson, (who made four more at a later period.) From 1832 to 1852, no more were made in England. Twenty years from the first English engine, and 12 years after steam fire engines had been in use in the United States, Shand, Mason & Co. altered one of the manual floating engines on the Thames into a steamer. Having made this great effort no more progress was made until 1860. Braidwood, the London Chief of Brigade, complained that the steamers "were expensive," and there "was not sufficient water to supply them!" (see his paper in the *Journal of the Society of Arts*, May 23d, 1856.) In 1860, Mr. Braidwood praises the Shand & Mason engine *on account* of "the large quantity of water it throws," etc. Braithwaite & Ericsson's first apparatus (1829) had a 10 H. P. engine, two horizontal cylinders and pumps, independent. The boiler was vertical, with fire-box tapering *downward;* the feed was hot. Braithwaite's second engine (1831) was 5 H. P.; had a steam cylinder 7×18 inches, with a pump $6\frac{1}{2}\times18$ inches (1·16 to 1), it was of the same style as the first; was taken to France and Russia.

Braithwaite's third (Liverpool) engine, had two horizontal cylinders, and three pumps, with speed of pump pistons reduced by cog-gearing. Braithwaite's fourth, the "Comet," (1832) was built for the King of Prussia to protect the public buildings of Berlin. It had two horizontal cylinders, each 12×14 inches, making 18 to 25 strokes per minute; and two pumps each $10\frac{1}{2}\times14$ inches; four hose-lines.

The fifth Braithwaite engine (1833) was experimental; the cylinders and pumps were double; the boiler nearly of locomotive pattern.

All these machines were straight-frame and horizontal, and without fly-wheel.

In 1856, G. Rennie & Son built, for the Woolwich dock-yard, a disk engine and disk pump, with a 13-inch cylinder and 9-inch pump. Making 320 revolution with 45 lbs. of steam, lifting water 10 feet, and with 62 lbs. water pressure at the nozzle, water was thrown through 3-inch hose, thirteen-sixteenth-inch nozzle, 145 feet high. The boiler was internally fired, the furnace being in the internal tube; small return flues on either side, and over the top of the furnace communicated with a horizontal smoke-box of horse shoe shape, saddling the furnace door.

In 1858, Shand & Mason built their first land steam fire engine. This had a vertical boiler, cylinder and pump, straight frame, and a vertical fly wheel, working athwart the frame. It seems to have had no air-chamber,

In 1850 one of their steamers, with $8\frac{1}{2}$-inch cylinder, 6-inch stroke, 218 strokes per minute, pump dimensions not given, raised 10 lbs. of steam in 6 minutes, 30 lbs. in $10\frac{1}{2}$ minutes; threw 161 feet horizontally with $\frac{7}{8}$ inch nozzle, 150 feet with 1-inch nozzle.

In 1860, James Shekelton, of Dundalk, built the first steam fire engine, made in Ireland.

Its boiler was like the "Silsby;"* heating surface 40 square feet; circulating plate in the water leg. The cylinder was vertical, 5×10 inches; the pump vertical and double acting, $4\frac{1}{2}\times10$ inches; 120 strokes per minute with 80 lbs. of steam. The crank worked in a slotted cross-head.

In 1861, Merryweather & Son, London, built their first land steam fire engine the "Deluge." It was of 30 H. P.; had a vertical boiler, a single horizontal cylinder 9×15 inches, and a double acting pump $6\frac{1}{2}\times15$ inches; worked direct without fly wheel. This engine had a "crane-neck."

In 1861, Shand & Mason made three railway steam fire engines, with double horizontal cylinders and pumps, and fly wheels and slotted cross-heads.

In 1862, they made a machine for Gothenburg, and one single and one double cylinder vertical engine for London. Their "No. 10" engine for the London Brigade had a single cylinder, $8\frac{1}{2}\times9$ inches; one double acting pump, 7×9 inches.

In 1862, Merryweather & Sons built the "Torrent," semi-crane neck, single horizontal cylinder pump.

In the same year, Lee & Larned, of New York, sent to the London International Exhibition a semi-rotary pump machine. This had a boiler 48×26 inches; cylinder $7\times8\frac{1}{2}$ inches, with a pair of light fly wheels; and ran 400 strokes per minute. The rotary pump was Cary's patent.

In the same year, Mr. Wellington Lee, of the firm last named, built in England a double cylinder engine. This had a vertical boiler with vertical tubes one within another, and a suspended "water-slab." The two horizontal cylinders were each $9\frac{1}{2}\times9\frac{1}{2}$ inches; the two pumps each $5\frac{5}{8}$ inches in diameter.

In 1862, William Roberts, of Millwall, built the first "self-propeller" made in Europe. It had a straight frame and three wheels, and was arranged to drive machinery, or for hoisting; had Benson's "forced circulation" boiler, where the water was kept circulating through horizontal parallel tubes; but this had to be altered materially. There were two vertical cylinders each 6×12 inches; cross-heads and side rods; two double acting (Robert's patent) pumps, each 9-inch diameter and 8-inch stroke; filling 8 inches of the barrel at each double stroke.

In the same year, Roberts built his second land steam fire engine, the "Princess of Wales" (not self-propeller.)

In 1863, Merryweather & Sons built the champion "Sutherland;" vertical boiler, semi-crane neck, horizontal direct-acting pump and cylinder.

In 1863, T. W. Cowan, of Greenwich, built a steamer for St. Petersburg. This had a vertical tubular boiler, 2 horizontal cylinders each 12×12 inches, side by side; four horizontal double acting pumps, each $5\frac{1}{2}\times12$ inches, two worked from the cross-head of each cylinder. (Poole & Hunt, of Baltimore, used similar horizontal pumps, but placed one over the other.) The funnel lowered on to a crutch. There was a large vacuum chamber.

In the same year, J. W. Gray & Son, of Limehouse, London, built a steamer intended for the "Crystal Palace" trials; but from bad workmanship it could not be got to work. It had a horizontal cylinder and pump, slotted cross-head, and fly-wheel.

G.

[*To be continued.*]

* Illustrated in our issues of March 10, and April 10 (vol. i, pp. 18, 26.)

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The Tunnel Through the San Fernando Mountains, which has just been completed, is the largest on the Pacific coast. Its length is 6,966 feet,

The Suez Canal.—The number of vessels which passed through the Suez Canal during the first eight months of the current year, was 1,009, as compared with 1,014 during the corresponding period of 1875, and 830 during the corresponding period of 1874. The transit revenue for the above-named period of 1876, was £811,412, as compared with £770,461 in the corresponding period of 1875. [*Saward's Coal Trade Jour.*, xii, 151.]

The Channel Tunnel. The New York *Sun*, after reviewing in full the promising features of this project, in a technical point of view, discusses the economical phase of the question. It places the cost at $50,000,000; on which a revenue of $5,000,000 should be yielded to make the work pay. The channel trade in 1875 (including that to Ostend) is stated at less than 500,000 passengers, and rather more than 2,000,000 tons of merchandise, including coal. Allowing 1,000,000 passengers and 3,000,000 tons of freight, the *Sun* estimates that it would be requisite to charge $2 per passenger and $1 per ton in order to pay 5 per cent. on the capital invested.

The terrors of an underground passage of seven hours and a half, pictured by the *Sun*, should surely be trebly counterbalanced by those of a passage, even of the same duration, over the channel, notorious for its roughness of transit. When one recalls the reminiscences of a noted literateur, when sea-sick—that during the first half hour he was afraid he would die, and during the rest, that he *would not*,—and when we remember that this same sea-sickness has proved more of a barrier between England and the continent than all other reasons, we must hope for a vastly greater increase in passenger and freight traffic than that in the *Sun's* estimate. Mons. Mottier, whose project was illustrated in our last issue, hopes for passenger receipts of $16,000 *per diem;* or nearly $6,000,000 per annum; "certainly," as we remarked, "a liberal enough estimate:"—referring to the 20 round trips daily of only one semi-submerged vehicle. The capacity of the tunnel, however, would be much greater than this; and as far as "trips in darkness" are concerned, we can see very little (if any) more danger, with proper precautions, in a trip through a tunnel, than in a flying night trip on some of our own American roads.

Furthermore, the engineers' estimate for the entire tunnel, including arching, is but £4,000,000; which Sir John Hawkshaw (see illustrated article in our issue of June 20) thinks it wise to double in order to provide for all contingencies; and with $40,000,000 instead of $50,000,000 as the capital or cost of construction, we need require but four-fifths the receipts named by the *Sun* as necessary to a dividend of five per cent. on the capital invested. Moreover, the passage should be accomplished in much less time than the $7\frac{1}{2}$ hours; and with a properly constructed tunnel and a well-managed road, the execution of the project should produce more than $50,000,000 worth of moral and pecuniary benefit to the countries which it will so greatly tend to unite.

—The great bridge across the Danube on the Prater, at Vienna, will be opened for traffic on the 21st inst. Its construction has cost more than $3,500,000. [*Eng, News*, iii, 331.

—Colorado is at work on a narrow gauge road from Floyd Hill, terminus of the Colorado Central to Idaho and Georgetown, with a branch to Central City, that will be extended into the Middle Park.

The Poughkeepsie Bridge.—The American Bridge Company, Chicago, which has taken the contract for the construction of the bridge across the Hudson river at Poughkeepsie, has directed the chief engineer of the Poughkeepsie Bridge Company to determine the position of the piers in the river, so that a thorough examination of the river bottom may be made, preparatory to beginning the work. The whole cost of the bridge and its approaches is estimated at $5,000,000. According to the terms of the contract, the construction company agrees to build the bridge, and to accept as payment

$1,000,000 in cash, and the remainder in the securities of the bridge company, It is announced that the money required has been provided for, with the exception of $15,000, and that work on the bridge will be begun in a very short time. [*Am. Manuf.* 10–7, 1876.]

MINING, METALLURGY AND MINERALOGY

A Vessel En Route for Philadelphia from the Artic Regions Laden with Valuable Minerals—An Account of the Expedition.—In a few days the schooner Era, of New London, Conn., will arrive at this port from the Arctic regions, laden, it is stated, with minerals of rare value, worth an immense fortune to those who sent the vessel on the expedition, a fact which will probably cause more than one similar enterprise to be projected. The history of the expedition is as follows:—More than two years ago Lieutenant W. A. Mintzer, of the United States Navy, while in the Arctic regions with the *Tigress*, chartered by the United States Government to search for the *Polaris*, found signs of rich deposits of mica and graphite along the shore of Cumberland inlet. Upon his return he interested Philadelphia capitalists in the matter, and was sent by them on a special exploration.

Last spring negotiations were completed by Lieutenant Mintzer, on behalf of his Philadelphia backers, with the firm of Short Brothers, New London, for the purchase and fitting out of a vessel for an expedition to the polar regions. The work was immediately undertaken and pushed with all the energy and secresy that was possible. The little topsail schooner Era, which had braved the dangers of that part of the world more than once before, under the command of Captain George Tyson, in the whaling trafic, was purchased, and made ready for a voyage.

A crew of nearly thirty men was secured, and the services of Esquimaux Joe, who had been with Captain Hall on the Polaris, and to whom was due in a large measure the preservation of life in Tyson's ice-floe party, and of Captain James Buddington, of Groton, Conn., an old whaler, well acquainted with Arctic navigation, and ice-pilot of the Tigress, were secured, the latter as sailing master of the Era. The Era took aboard, as part of of her equipment, some 3,000 feet of tramway, a quantity of mining tools, and lumber for toolhouses. All questions of the curious were met with evasive answers on part of those engaged in these preparations, and the slightest publicity given to their operations was resented.

At length, on the 5th of June, without having attracted much notice, the expedition sailed from New London under command of Lieutenant Mintzer, who, it is said, had obtained a six months' leave from the Government for this purpose. The impression was given out in New London that he was going after specimens of Arctic fauna, flora, and minerals for the Smithsonian Institute; but this evidently was a secondary object, and was used as a veil to cover the principal aim of the expedition. Between two and three weeks ago the Era touched at St. John's, Newfoundland, on her return. Lieutenant Mintzer left her at that point, she continuing her voyage towards New London under Captain Buddington, and he taking more speedy modes of transportation in the same direction. He was in New London last week, and has since come to this city. He exhibits a few ornithological, cranial, and other specimens brought for the Smithsonian Institution, but absolutely refused to give any information regarding the size and character of the Era's cargo or regarding the occupation of his crew during their stay at Cumberland Inlet. But the facts, together with the recollection of old New London sailors who were on the Tigress, of graphite and mica fields, lead the more intelligent and best informed to believe that a quantity of both those valuable minerals is now *en route* to this city.

A despatch from Norwich, Conn., states that the Era's sails not being equal to bringing her into port, she put into New London about 5 o'clock yesterday afternoon to refit, and will continue her voyage in a few days. The officers and sailors preserve strict reticence, but a few facts have nevertheless been ascertained. She was forty-three days on her journey from New London to Cumberland Inlet, having been delayed eleven days in the ice. On reaching a point known to whalemen as Nialtic Valley, the crew were put to work laying a tramway, building shanties, and mining. The miners worked in two gangs in different quarries, about 1,300 feet above the level of the sea. The tramway did not reach all the way up, and the mica was transported much of the distance on the backs of the workman. The mica was found in veins some ten feet below the surface of the ground, and was principally blasted out. Some of the blocks are remarkably large and clear, the sheets measuring eighteen by twenty inches, and some blocks weighing fifty pounds. Altogether about fifteen tons were excavated, which exhausted these veins. Six weeks were thus spent. Three days were spent in further prospecting, after which the Era sailed for home. The sailors named their diminutive village of three wooden structures "Mintzerville," in honor of their commander.

Mica, which is used more for stoves and lanterns than anything else, is found in good quality in but very few mines in the world. The best comes from Siberia, Sweden, and Norway, though some is found in Canada, New Hampshire, and elsewhere. In good plates for stoves it is worth $10 a pound. Graphite, from which lead-pencils are made, is still more rare and precious. It is found in small quantities, but very pure, in Ceylon. The most famous mine was in Cumberland, England, where it occurred in small nests or nuggets of the size of the fist or smaller in trap rock. So valuable was this mineral on its first discovery that an act of Parliament was passed to protect it from plunder, and the utmost precaution was taken to save every particle it yielded. This supply has since given out altogether, and until this discovery in the Arctic regions nothing like it has anywhere been found, although a poor article is mined at Sturbridge, Mass.; Brandon, Vt.; Ticonderoga, N. Y.; Wake, N. C.; St. John, N. B., and elsewhere. [Philadelphia *Evening Telegraph.*]

—*The Eureka Iron Mining and Manufacturing Company's Furnace*, situated at Oxmoor, Alabama, is running day and night, making about 30 tons of pig-iron every twenty-four hours, which find a ready market at remunerative prices. The company is, furthermore, engaged in erecting a new furnace with a capacity of fifty tons, which, when completed, will increase the productive capacity of the works to eighty tons of iron daily. The company is employing native coal and ore, and the cost of manufacturing pig-iron is affirmed to be not more than the cost of the ore in its crude state in Ohio and other portions of the west. [Abr. from *Jefferson Independent*].

—*The Construction of the Great Oil Pipe Line* to the seaboard cities, to which project we have occasionally alluded in these columns, will in all probability be somewhat delayed by legal proceedings instituted by the Pennsylvania Railroad Company, in order to test the authority of the Pennsylvania Transportation Company for the construction of the line.

—*The Exportation of Anthracite Coal* to South America, we learn, is about to be undertaken by the Reading Railroad Company. The countries named, up to the present time, have been largely supplied with coal from England.

A very Valuable and Extensive Deposit of Plumbago is said to have been discovered in Longswamp township, Berks county, Pennsylvania, a district that has been known for its wealth of iron ore. The discovery was made upon the farm of Mr. William Long, a short distance from the village of Mertztown. The tract of land upon which the plumbago is found has been leased by Reilly & Co. Extensive preparations are being made to develop the bonanza. The firm will commence to produce the plumbago in large quantities as soon as the necessary machinery is erected. The deposit is between seven and eight feet in depth, and the mineral is of the best quality. It is said there are similar deposits elsewhere in the region, and persons are now engaged in prospecting. So far, however, no new discoveries have been made. [*Am. Manuf.* 10, 7, 1876.]

Chromeisen as a Substitute for Spiegeleisen.—Recent experiments have proved that by using chromeisen instead of spiegeleisen, extremely soft steel is obtained, for rods made for experiments were very easily bent, even by hand. It is seen, from these attempts to replace spiegeleisen by chromeisen, that the use of the chrome iron alloys is limited, and the steel obtained is for most purposes too soft for the manufacture of such materials as rails, axles, ties. etc. It also appears that during some experiments with the cbrome iron alloys a strange phenomenon was observed. It is well know that chromium is extremely hard, and scratches even hardened steel; meanwhile an alloy was obtained which was malleable, and in a fresh state could be easily bent. It was further remarked that sometimes on opening the crucibles nothing but slag was found; but in breaking the crucibles, the alloy was found to be at the bottom of them. That may be attributed to the corrosive properties of the liquid alloy, which often penetrated even through the bottom of plumbago crucibles. The above mentioned alloy was analyzed, and the following average composition was found: Metallic iron, 96·40 per cent.; metallic chromium, 2·30 per cent.; carbon, traces; lime, silica, 1·30; total, 100·00. By melting a mixture of cast iron, tin and lead, in the following proportions, a very liquid alloy is obtained: Cast iron, 79·00 per cent.; tin, 19·50 per cent.; lead, 1·50; total, 100·00. The alloy has a very handsome appearance, and fills perfectly well the casting moulds; thus it could be used for casting small articles. The alloy is to some degree malleable. [*Ironmonger.*]

Lancaster Co., Penna., Nickel Deposits. The facts given below, says the *American Manufacturer and Iron World*, concerning the nickel deposit, which was discovered some time ago near a peculiarly formed section of country called the Gap, on the highlands separating the Chester and Pequea valleys, in this State, are occasioning considerable excitement among scientific men, speculators and others, who are in any way interested in mineralogy or mining operations, as it is believed to be one of the greatest, most remarkable and valuable bonanzas of the age, and that further development will reveal something still more extensive and important than this vast and splendid nickel formation.

Ever since the mine was developed by the company owning the property, many persons have visited the scene of operations, and viewed with deep interest the process of mining, and rendering the ore into merchantable shape. The discovery has made a hitherto comparatively unnoticed and seldom visited district a centre of attraction, and a busy and animated field of employment for many workmen, and is destined to create still more attention at no distant day, as the magnitude and richness of the deposit become more generally known.

This formation of nickel ore is the heaviest so far discovered in any part of the globe, and this is the only mine that has been productive enough to warrant opening in America. In the same region, and in close proximity to the mine, there are formations of copper, iron, and limestone. The nickel ore was first found some time in the year 1856, though copper, which is produced from the same mine, was unearthed many years ago in the same spot. It is only since nickel has been generally used that notice was directed to this deposit, and mining commenced.

The ore is exceedingly rich, of a grayish tint, very heavy, and so hard and closely united to the surrounding extraneous substances, that it is exhumed entirely by blasting. As soon as the ore is mined it is crushed into small pieces, and then transmitted to kilns of a capacity of from eighty to ninety tons each. It is then subjected to heat created at first by burning wood, and which is continued by the conversion of the evaporating fumes. The manipulation is concluded by the fused metal being placed in a smelting furnace and undergoing a process similar to that adopted in the preparation of iron ore. The production is large, and increases with development.

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Antidotes for Mushroom Poisoning.—Prof. Schiff has demonstrated that muscarina, the poisonous principle in mushrooms, may be promptly and efficaciously counteracted by the administration of atropine or daturine, but particularly by the latter. [*The Pharmacist*, ix, 298.]

The Pneumatic Tubes at the Western Union main office in New York, are a practical success. About one thousand messages are received through them from 14 Broad Street, daily, and about 750 sent. The expense of laying these tubes was about $8,000, but the cost of working is much less than if wires were used, while business can be handled much quicker and without possibility of mistakes. [*The Operator*, 10-1-6.]

MISCELLANEOUS.

The Forests of the World and their Reckless Destruction. The forests of Europe are estimated as being 500,000,000 acres in extent, or about 20 per cent. of the whole area of the continent. In North America it is reckoned that 1,460,000,000 acres are covered with trees, of which 900,000,000 are in British North America. In South America the forests occupy 700,000,000 acres. The proportion of forest land to the whole area of Europe, as above stated, is computed at 20 per cent. in America 21 per cent. Supposing, therefore, 20 per cent. to be the proportion in Asia, Africa, and Australia, the grand total of the forests of the world would cover a space of over 7,734,000 geographical miles. The areas of State forests and woodlands are estimated at the following figures in the following European countries: Prussia 6,200,000 acres; Bavaria, 3,294,000 acres; France, 2,700,000 acres; Austria, 2,230,000 acres; Hanover, 900,000 acres; Würtemburg, 469,000 acres; Saxony, 394,000 acres; England, 112,376 acres.

The range in the height of trees varies from the miniature Alpine willows of a few inches in height to the stupendous Wellingtonia, which grows to the height of 350 feet, although it is stated that one of the eucalypti often reaches a height of 450 feet in Victoria. In Slavonia a tree called the sapin attains a height of 275 feet, and the umbrella pines of Italy 200 feet. The California big tree is said to girth 96 feet. The destruction of woods and forests, however, is very enormous, and in the majority of instances no attempts are being made for their reproduction. In South Africa, we are told, countless numbers of beautiful forest trees are destroyed and laid waste annually. In New Zealand the 30 per cent. of forest existing in 1830 had sunk to 28 in 1867, and to 18 in 1873, which rate of reduction, if continued, would result in the total destruction of New Zealand forests by 1889. In America, in the United States especially, the consumption of timber is enormous, and although public attention has been called to

the matter, and the United States statute of March, 1875, imposes a fine of $500 or a year's imprisonment for wanton injury or destruction of trees, and also a fine of $200 or six months' imprisonment for allowing cattle to injure trees "on national grounds," the yearly consumption and improvident use of timber is almost incredible.

Although, says the *Scientific American*, there are no available statistics to show the exact rate of speed with which they are using up the wood supply, it is easy to see that it is being done with great rapidity. Taking the legitimate use of lumber, industries based on its manufacture constitute the second in point of magnitude in America, and are exceeded by the iron interest only. About 150,000 persons are stated to be employed in producing sawed lumber alone; $143,500,000 are invested therein, "and 1,395,000(?)lath, 2,265,000,000 shingles, and 12,756,000,000 feet of timber are yearly manufactured." On the secondary interests based on the use of lumber as a raw material—carpentry, cabinet-making, shipbuilding, etc.—millions of people are employed. According to Professor Brewer's assertion, wood forms the fuel of two-thirds of the population, and the partial fuel of nine-tenths of the remaining third. Add this to the former estimate, and some idea will be obtained of the enormous drain upon the American forests that is constantly in progress. As a fact, it is well known that in 1871 as many as 10,000 acres of forest were stripped of their timber to supply Chicago with fuel, and yet no attempt is made to reproduce. [*Land and Water*].

September was a great month for the Exhibition, as will be seen by the following official figures: The grand total of admissions, paid and free, amounts to 2,439,689. Of these, 2,130,991 were paid, including twenty-five cent admissions and those to the stock-yard, the total receipts being $948,081, or nearly $1,000,000. The average daily attendance during the month was 81,961.

A Steamship Line from Philadelphia to Brazil.—"At the Maritime Exchange recently, a meeting of merchants, manufacturers, shippers and others, was held for the purpose of discussing the feasibility of establishing at an early date a line of steamers to ply between Philadelphia and Brazil.

Philip Fitzpatrick, Esq., the chairman, after calling the meeting to order, introduced Mr. Frederick Guscetti, a civil engineer, who spoke at some length in favor of the enterprise, and said that the Brazilian Government encourages emigration to that country, and provides means to all who wish to settle in that locality. The speaker stated that the Government of Brazil offers a subsidy of $108,000 gold per year for a line of steamships between that country and this city. Appropriate addresses endorsing the project were made by Mr. A. F. Damon, Mr. H. L. Gregg, and others, after which a committee, consisting of Messrs. H. L. Gregg, William Brockie, J. B. Watson, A. F. Damon, and J. F. Craig, were appointed to agitate the question. The meeting then adjourned to meet again at the call of the Chair." [*Philad'a. Evening Telegraph.*]

"The project is certainly well worth considering. An intermittent effort has been made by New York parties to keep up a company, but the capital was insufficient and there are now but two lines to South America. One of these was newly established by Mr. Hemenway, the wealthiest merchant of Boston, just before his death, a few months ago, and bids fair to be a great success. With the subsidy of $108,000 gold a year, which the Brazilian Government offers, and with the amount that could be realized from carrying the mails, it would seem as if the success of the enterprise were not so problematical as to deter capitalists from investing. The recent visit of Dom Pedro must give a decided stimulus to our trade relations with that thriving South American empire." [*Philadelphia Times.*]

American and Asiatic Cable.—Celso Cæsar Moreno, on behalf of himself and fellow corporators, filed at Washington, September 26th, in accordance with the law of Congress granting them a franchise for telegraphic communication between America and Asia, a written acceptance of the terms and conditions as imposed by that law in the office of the Secretary of State. [*The Operator*, 10-1-6.]

Novelty in Marine Architecture.—The Canadians find the ice which for nearly six months every year blocks the St. Lawrence a great barrier to direct European trade. How to overcome it is a problem their shipbuilders have been endeavoring to solve, and there has recently been launched at Quebec, a vessel designed for making winter voyages down the St. Lawrence to Prince Edward Island. If she is successful other and larger vessels on the same model may be built for European trade. She is named the *Northern Light*, and will be fitted for sea by November. She is sheathed with one of the hardest of woods—greenheart—and plated with iron. Her construction is such that there can be no right-angle pressure from ice on any part of the hull. The draught of water aft is 17 feet, and the screw is so placed that there will be at all times at least 5 feet of water above the upper blades, so as to prevent contact with ice. Her engines will be of 700 nominal horse-power. [*Iron*, viii, 423.]

The Total Number of Immigrants who arrived in this country during the fiscal year 1876, was 169,986, against 227,498 in the fiscal year 1875; 313,339 in the fiscal year 1874; 459,803 in the fiscal year 1873; and 404,806 in the fiscal year 1872. Of those arriving in the fiscal year 1876, no fewer than 22,781 came from China, of whom 260 were women.

—According to data gathered by an agricultural paper, the quantity of flour consumed annually in the United States is about one barrel for each person; equivalent to four to five bushels of wheat. For the past eight years the average annual exportation of flour to foreign countries has been 3,200,000 bls. As the population of the United States is about 42,000,000, the aggregate quantity of flour produced each year by American mills is over 45,000,000 barrels. Placed head to head in a straight line these barrels would extend over twenty thousand miles, or four-fifths the distance around the globe.

—Our English exchanges are engaged just now in discussing a novelty (if a return to the primitive custom can be called by that name) in the art of milling, which is being tried in England. It is a device which dispenses with the use of burrs in a mill, performing their work by means of innumerable little trip hammers which crush the grain. We have seen no scientific account of the machine or its working; but some journals, with that enthusiasm with which everything new is greeted, affirm that it is a success, accomplishing better results in the quality and quantity of the flour at only one-fifth the cost of the machinery ordinarily used for the same purposes. [*American Miller*, iv, 100.]

*Capt. V. L. Cameron's Journey through Equatorial Africa.**—Capt. Cameron said that soon after entering the country from the east coast, he came to a large plateau, 4,000 feet in height, encircling Lake Tanganyika, and forming the water-shed between Congo and the streams flowing into Lake Sangora. Another table-land to the south rose to the height of 3,000 feet. The water-shed between the two basins of the Lualaba and the Congo at that part is a large, nearly level country, and during the rainy season the floods cover the ground between the two rivers, and a great portion of it might easily be made navigable. One thing he noticed in Africa was this system of water-sheds, dividing the country into portions, each having its own peculiarity, and also that in each there was a difference in the habits of the natives. Within twenty days he crossed the Nsagara Mountains, and came upon a level open country where a great quantity of African corn was grown, the stalks of which rose to the height of from 20 to 24 feet. In this country no animal could live except the goat, the tsetse fly being destructive to all others. The principal geological formation was sandstone. A few marches brought him to Ugogo, an extensive plain broken by two ranges of hills, composed of loose masses of granite piled together in the wildest confusion. The soil was sandy and sterile. Coming to the country of the Ugari, he found a tribe almost identical with Unyamwesi. The principal streams of this district fall into the Mulgarazi. Unyamwesi was the commencement of the basin of the Congo He believed that the natives of Unyamwesi were of the Malay race. They had crossed a great deal with negroes, and had lost the distinctive color and distinctive marks of the race, but their features were much the same as the dominant races in Madagascar. Ugaro is a large plain nearly as flat as a billiard table. The people here were different from the Unyamwesians; they had not got the same features or the same tribal marks. After passing over the mountains of Komendi, which are an offshoot of the mountains round the south end of Tanganyika, they came to a fertile land, much of it laid waste by the ravages of a neighboring tribe. All the mountains in that district were of granite. There was there a large quantity of salt, and what was remarkable was that the rivers ran perfectly fresh through soil which, when the natives dug wells, gave water which was full of salt. At Ujiji the people are of a different race from those already described, as they shave their hair differently and have not the same features. Along Lake Tanganyika, in some places, there were enormous cliffs and hollows of rugged granite lying in loose boulders; in other places the cliffs were of red sandstone, and in others a sort of limestone and dolomite. At one place, he saw exposed on the shores of the lake large masses of coal. Passing down to the south end of the lake, he found it regularly imbedded in cliffs 500 to 600 feet high, with waterfalls discharging themselves down the face. Travelling along the side of the lake, he came to the Lukogo, a large river more than a mile wide, but partly closed by a sort of silt, on which a floating vegetation was growing, a clear passage, however, being left of about 800 yards. After proceeding some four miles up the river, Capt. Cameron's boat got jammed amongst the floating vegetation, which grows to the thickness of two or three feet, and it was with difficulty the boat was extricated. The Kasongo country was next reached, the principal characteristic of which was the extraordinary trees, of which boats a fathom wide are sometimes made. Crossing the mountains of Bambara he arrived at Mamyuemba. Here he found the race entirely different from anything he had yet seen. The houses were differently built, the people were differently armed, dressed their head differently, and there was no tattooing to speak of. The villages were built in long streets thirty or forty yards wide, two or three streets being alongside each other, and a space left between the houses, which were of reddish clay with sloping thatched roof—the only houses of that description he saw in the interior of the country. All the Mamyuemba are cannibals. Journeying northwards, but still in Mamyuemba, a district was reached where iron was very plentiful, and where large forges were at work. Many of the spears and knives which they turned out looked as if finished off by a file or polished by some means, although all done by hand-forging and patient labor. The Lualaba River was next reached, which is about 1,800 yards in breadth. The southern shore is occupied by a tribe called the Wagenga, who do the whole carrying business of the river, being the only canoe proprietors, who take for pay the products of the country to the different markets. The young women make immense quantities of pottery in the mud and back water, which they exchange for fish. After referring to a country between Nywangi and Loami, where a palm oil grows in great profusion, Capt. Cameron passed through Kilemba, and reached Lake Kigongo. This lake is covered with floating vegetation, on which the people build their houses, cut a space round about them, and so transform their habitations into floating islands, so that when desirable they change the locality from one place to another. Coming to the coast he passed through one of the most magnificent countries in the world to look at, possessing a climate in which any European might live. The Portuguese had been settled in this neighborhood for thirty years. The whole of this country was just one vast slave field. In the country there was a vast mineral wealth and an ordinary population, that, with education, might be rendered very industrious, instead of carrying on a continual warfare against each other for the purpose of obtaining slaves.

*Abstract of a paper read before the British Association for the advancement of science. [From *Nature*, xiv, 489.]

The Petroleum Pipe Line.—There has been a great deal said recently about the scheme for conveying petroleum from the oil regions to the seaboard through a line of pipe, thus doing away with the present system of transportation by rail. Quite a number of papers, both in Philadelphia and Pittsburgh, have demonstrated to their own satisfaction, at least, that the whole scheme is a mistaken if not a fraudulent one, and that the pipe line stockholders will never again see the money they put into it. We do not know any anything about the merits of the case; but as this is a new feature in the great industrial enterprises of the day, it is at least worthy of record.

The plan, then, is to lay a line of four inch pipe, underground, all the way from Brady's Bend, on the Allegheny river, over the mountains and through the valleys, to Gettysburg, where the main line will branch, one section going to Philadelphia and the other to Baltimore. Pumping engines will be erected wherever necessary, the present plan contemplating stations at every fifteen miles along the route, each to be supplied with an engine of 100 horse power. The engineer in charge is Mr. Harman Haupt, of Hoosac Tunnel fame, who is pretty well known here in the coal region. As to the location, Mr. Haupt says:

"I propose a line ascending rapidly from the Allegheny river and following the table lands along the water sheds of the country, passing about twelve miles north of Indiana, and striking the Ebensburg branch of the Pennsylvania Railroad at Bradley's Station; thence to Cresson, along the pike, in close proximity to the railroad; from Cresson an air line of fourteen miles will strike the intersection of the Hollidaysburg Branch at Brook's Mills; thence following the general direction of the road. The next sixteen miles to Great Aughwick Valley will be near railroads, and from this point to Newville, thirty miles, will be over a broken country, requiring the construction of roads for distribution. The total cost of three hundred miles of four-inch pipe, with the expense of hauling, cutting woods, laying and ditching, etc., is estimated at $1,250,000. The cost of transporting 1,500,000 barrels of oil from Brady's Bend to Philadelphia by a pipe line has been estimated at $250,000, which is 16½ cents per barrel, while the minimum cost of carrying oil by rail the same distance (395 miles) is 39½ cents per barrel." [From the Pottsville *Miners' Journal.*

CENTENNIAL NOTES.

ENGINEERING INSTRUMENTS.

Heller & Brightly, Philaadelphia.

The following notice, from the pen of Prof. J. B. Davis, of Ann Arbor, Michigan, special correspondent of the Chicago *Engineering News*, appeared in a recent number of that valuable journal:

"Among the most prominent exhibits of this class is that of Messrs. Heller & Brightly, of 33 N. 7th St., Philadelphia. This is the firm that has done more than any other in this country of late years to increase competition in the trade, and to wake up the different makers to a sense of the many improvements that may be made in the instrument in commons use. Indeed, it was said of them by one of their powerful rivals that they had made more progress in the manufacture and improvement of their instruments than any one else. The gentleman really went further than I am ready to accompany him when he said that they were the only ones who had advanced much, if any, from previous practice. Whilst I regard this as far from an exact statement, it illustrates the respect in which they are held by those who compete against them. They have on exhibition a fine collection of their various products. Here is a list of what may be seen: Two engineer's Y levels, complete transit for mining use, plain engineer's transit, geological transit, 4-inch limb; tunnel transit, used at the Musconetcong and Nesquehoning tunnels; surveyor's compass; solar transit, Benj. Smith Lyman's patent solar apparatus beneath the plate; mining and reconnoisance level; combined transit and levelling instrument; two mining and reconnoisance transits, 5-inch limb; large mining transit, 7-inch limb; and a plane table. Now there is not one of these instruments that does not show in some one or more ways the inventive genius of the firm. There are numerous details worked out and devised to improve upon old ones. It gives great pleasure to be able to say that in almost every instance the change is an improvement. This, however, is not always the case. Besides, it is a matter of opinion as to what are improvements. It can be said with great force that in the work of this firm is the place to hopefully look for real improvements. Whoever is to invest in instruments should give them an examination. It is of course quite impossible to mention all of the devices shown here, but a few will be given. The large mining transit has an adjustable lamp stand provided with it. This stand may be easily fastened upon one of the legs of the tripod and may be quickly set so as to support a lamp at the proper place for illuminating the cross-wires or for reading the verniers. The same transit is provided with an extra detachable telescope on the end of the transit axis for sighting in a vertical direction. The device for attaching this telescope is neat and efficient. There is also shown a large 15 second transit with three levelling screws. This instrument is provided with an arrangement of parts in the tripod cap that operates in a manner to accomplish the same result as is accomplished by the ordinary shifting tripod cap, or "shifting tripod," as it is called. I think this arrangement for a three-screw instrument is new. The alidade to the plane table has the movable edge to the rule that is made by this firm for those who desire it. I will say in passing that an edge of this kind to a rule, whilst it may introduce no appreciable error into the work, is not a mechanically perfect construction. The whole trouble which this device is intended to meet, and many other besides, can be fully overcome, or avoided, by setting the centre of the board over the point from which observations are to be made, with a plumb-bob, in the same manner that a transit is usually set. Another interesting invention is a device for detaching an instrument from the tripod head at the upper parallel plate. The height of the instrument is not practically increased.

In closing my remarks about the exhibits of this firm I wish to say that I think their most valuable contribution to the advancement of their business is the spirit of invention and adaptation which they have awakened amongst their competitors. Since I believe we have not seen the full development of good principles of construction in our common instruments, I look for particularly valuable results from the spirit above alluded to. Whilst I regard with satisfaction the disposition of engineers to adhere to a well tried and valuable types of construction in any department, I am sure this conservatism may be carried too far and much be lost thereby. I think this has been the case with those who have had to use engineer's instruments. I am of the opinion that much has yet to be done to induce men to be ready and willing to try any new devices applied to these constructions. The practice in this regard seems to have improved much within a few years, but there is much to be done. It is in the hope that these remarks may lead some to consider this matter that they are written.

I cannot close my account of this firm without mention of the excellent plummet lamp shown by them. One is provided with a "compensating ring" which is simply a ring upon the sides of which rest two trunnions, from the plummet and from opposite sides of 90° from the other points proceed two light, chains which meet some ways above the plummet where the string is attached; the lines of the attachment of the chains and the bearings of the trunnions are consequently at right angles with each other. Another has, in addition to this ring, in the place of an ordinary burner, a safety lamp. Both arrangements are the invention of Professor Eckley B. Coxe."

The Duncannon Iron Co. shows, at B–25, a nail machine with automatic feed, turning out 200 nails per minute, in sizes of 2 to 4½ inches long.

The Pennsylvania Tack Works, of Norristown, show at B–26, some ingenious and delicate tack-machines, each making 400 revolutions per minute, and turning out well-finished small tacks.

S. G. Reed's Tire Heater, E–69, is a wheel with sliding spokes, having four gas-burners attached to a cross bar at the end of each spoke. It will enclose a wheel from 3 to 6 feet in diameter, and is stated to remove a tire in five to ten minutes, with a gas consumption of 10 cu. ft. per minute.

The Hamilton Steeled Wheel Co., of Philadelphia, show at D–68, excellent specimens of car-wheels cast from cheap grades of Anthracite iron, by the Hamilton process.

Forstner's Auger, shown at work, driven by the Stow & Burnham flexible shaft, at D–68, has the cutting part provided with a circular band or flange, of the size of the required hole, and the extreme lower edge of which is sharp, and slightly projecting from the lip or lips; the latter receding from their junction with the flange to the center, about 1-32″, so that the edge of the flange and that part of the cutting lip adjacent thereto will enter the wood first and cut deepest, leaving the bottom of the hole convex. This auger bores straight and clean, without tearing or splitting, even near the end or side of a soft board; can be withdrawn without reversing, and will enlarge a smaller hole or bore by a greatly overlapping hole, with ease—none of these points being possessed by the ordinary screw-point auger.

W. C. Allison & Sons, Philadelphia, show at B–24, steel and wrought iron tubes, car forgings and breaks, bolts and rivets, etc. Allison's tube coupling is produced by expensive plant, but makes an excellent joint; the threads on the pipe and collar being slightly tapering. Doty's revolving road scraper is shown here in model form,

The National Tube Works, of McKeesport, Pa., furnish the steam pipes in Machinery Hall. These are all lap-welded, from fifteen inches downward, and are well worthy of notice, as well for the size of the larger, as for the perfection of the screw threads thereon. Where a large and a small pipe are joined, the flange on the smaller pipe is bored and tapped eccentrically, so as to keep the lower sides of the pipes in a right line and prevent trapping. The Company shows a lap-welded pipe, threaded and flanged, eighteen inches in diameter.

The Chalmer & Spence Co., of New York, shows an excellent and largely used non-conducting covering—consisting of a coarse wire netting surrounding the pipe, and kept from contact therewith by sheet-iron studs and thimbles, which keep it about an inch from the pipe or boiler. On this netting is spread a plastic or other non-conductor.

The Utica Steam Gauge Company has at D–73, a handsome exhibit of revolution counters and gauges; Wood's test pumps, and square inch valves for gauge-testing. An electric attachment to one of the revolution counters, permits of the registration of the revolutions of the great Corliss engine, 450 feet distant.

J. D. Lynde, of Philadelphia, shows at B–71 a double (or "Duplex auxiliary") horizontal engine, having for piston-rod guides, hollow cylinders bolted to the bed-plate, and of sufficient diameter to clear the connecting rod when at its greatest angle with the piston-rod. While this plan is cheap in execution, it renders the cross-head difficult of adjustment. The governor is intended to entirely throttle the steam supply of one cylinder before affecting that of the other, or, in other words, to allow one cylinder to do ordinary work, throwing on the other cylinder in case of an extra load.

Mr. James Watson, of Philadelphia, shows at C–31, an improved gap-lathe, for turning face-plate work of greater diameter than can be swung clear of the general level of the shears. This is permitted by the ordinary "gap," or depression in the shear level, next the face-plate; but in place of the ordinary insertable "gap-piece," there are at the bottom of the gap auxiliary shears, in which the saddle is supported (as soon as it leaves the higher shears) by an extension reaching down to the lower level.

The Brayton Ready Motor, described in full, and illustrated in an issue of February 10th, appears at A–71, in a double-acting form; an improvement perhaps suggested by our article referred to.

Poole & Hunt, Woodbury, Maryland, show at C–79, as a specimen of green-sand casting, a solid pulley-wheel, eight feet in diameter, and with a thirty-inch face; there being a double set of arms; one near each end of the hub. This firm also exhibits a thirty-inch Leffel turbine, with a very noteworthy cast-iron globe-flume and penstock, and some excellent inserted wood-teeth mill gearing.

Band Saws.—Richards, London & Kelley show some elaborate specimens of band sawing, one American, and the other by Perin of Paris.

Charles W. Ervien & Co., Philadelphia, show, at B–69, a horizontal engine, 18 × 36-inch cylinder, and having a novel bed or frame; a broad, flat casting, with hollow, box-like uprights to support the cylinder and guides, and a long curved, hollow, horn-like projection, on the end of which is placed the main bearing.

Colwell & Brother, New York, show at E–79 an immense vacuum pan for sugar boiling. The pan is eight feet in diameter; is supported on iron columns, three stories high; and has inside it four copper worms into which steam is let, for the purpose of concentrating the solution. In the second story is a large receiver for the magma or semi-fluid product of evaporation or condensation. On the first floor are the circulating pumps and the centrifugals. These last receive the magma from the receiver in the second story, and separate the sugar from the molasses. The apparatus produces fifteen hogsheads of sugar in a single operation of three hours' duration.

The Toronto Car Wheel Company has two pairs of thirty-three-inch cast-iron wheels, Washburn pattern, pressed on the axles; and one pair of twenty-eight-inch wheels, meter gauge, and "Elmslie" pattern. This last has a plate with circular corrugations, and has curved ribs on the back and extending from hub to rim, and intermediate short ribs or brackets extending a short distance from the rim and the hub. Their weight is marked "350 lbs."

The same company shows a spoke-wheel for locomotive trucks, and a 24″ plate wheel with radial corrugations, from hub to rim.

The Washburn & Moen Manufacturing Company, of Worcester, Mass., shows a huge column, 12 feet high, of very long coils of clean new wire. One of these coils, weighing 525 lbs., is over a mile long, without weld or joint, and was made from American pig. This firm also shows ramrod wire in bundles, a column of broom wire, and coils of special kinds of wire for pins, belt-hook, telegraphs, clothes-lines, pianos, window-screens, hay-bales, etc.

Phillips, Nimick & Co., Pittsburg, show a fine specimen of forging; also, saws and saw steel, test knots of cold tied iron; a wrought iron expansion joint for water pipe, rolled in two semi-circles and welded; "S. S.," (Sligo special) plates tested to 77,000 lbs. tensile strain, and the "Sligo" fire-box, 106″ in diameter, 64,000 lbs. tensile strength.

—Randolph Bros., of 111 Broadway, N. Y., show a ditching and excavating machine, which we hope to illustrate and describe in detail.

—Beard & Co., of St. Louis, show burglar-proof safes with round doors *screwing* into the jambs; and which will be noticed in full later on.

—S. R. Foster & Son, St. John, New Brunswick, show fire-proof shutters and shutter workers. The shutters are made of durable wrought iron frames and plates, with the space between filled with water. We shall describe these in our general matter under the head of Fire Protection.

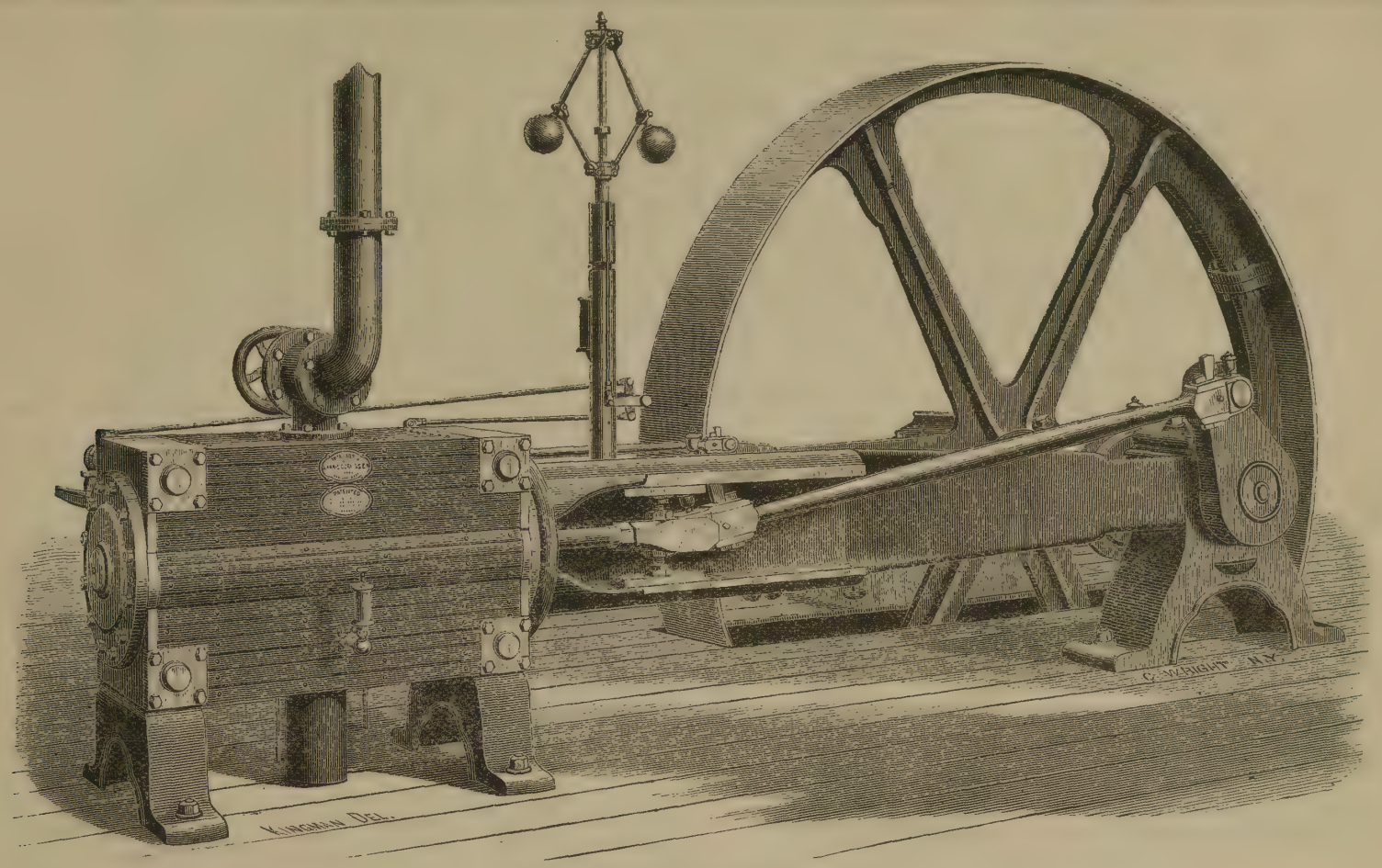
—Mr. James W. Kensett, of Troy, N. Y., shows patent fire-proof plastering, roofing and flooring, worthy of special notice from us, which they will receive at another time. Shown in west corner of Carriage Annex.

THE

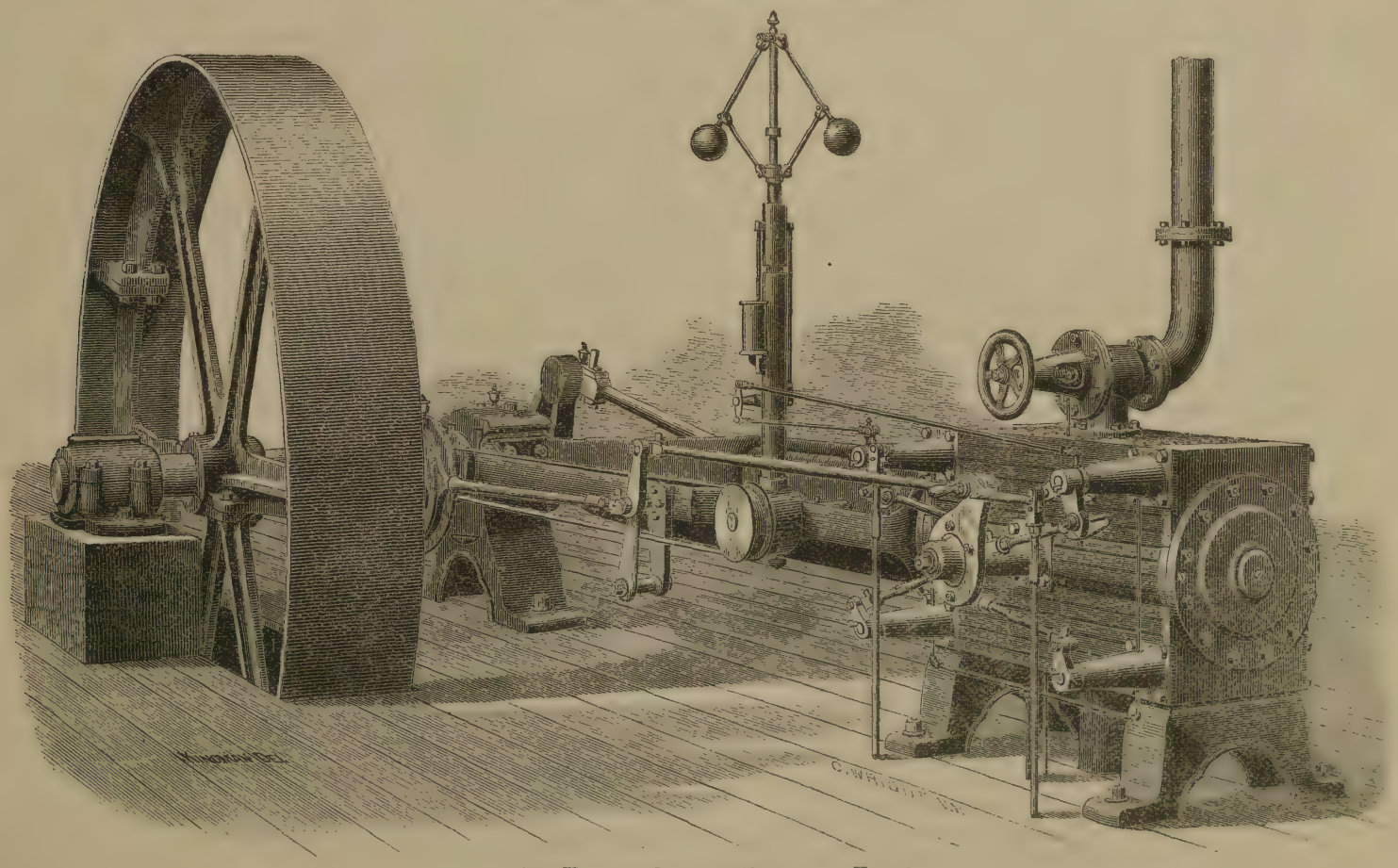
POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, OCTOBER 28, 1876. NO. 17.



THE HARRIS-CORLISS ENGINE.—FIG. 1.



THE HARRIS-CORLISS ENGINE.—FIG. 2.

THE HARRIS-CORLISS STEAM ENGINE.

MADE BY WILLIAM A. HARRIS, PROVIDENCE, RHODE ISLAND.

No stationary engine has, since the time of James Watt, held or maintained the prominent position at present occupied by the Harris-Corliss Steam Engine. In addition to the advantages possessed by the ordinary type of Corliss engine, the Harris-Corliss engines possess those especial improvements which have given to them on both sides of the Atlantic their reputation for economy in the consumption of fuel and superiority of construction. The especial features of the engine, which we herewith present in our engravings, are improvements which add greatly to efficiency and accessibility.

The principle of these is an arrangement of parts whereby, not only are stuffing-boxes and packing dispensed with, but the valve-stems are made self-packing and lubricating, while at the same time the number of parts is reduced. Before the introduction of this improvement, the abrasion and wear due to the thrust of the valve-stem

was resisted by a collar on the valve-stem bearing against a heavy cast iron bracket bolted to the outside of the cylinder, and the valve-stems were kept steam-tight by means of stuffing-boxes and glands. The improvement to which especial attention is called is shown in Fig. 3. It removes the thrust-collar from the outside to the inside

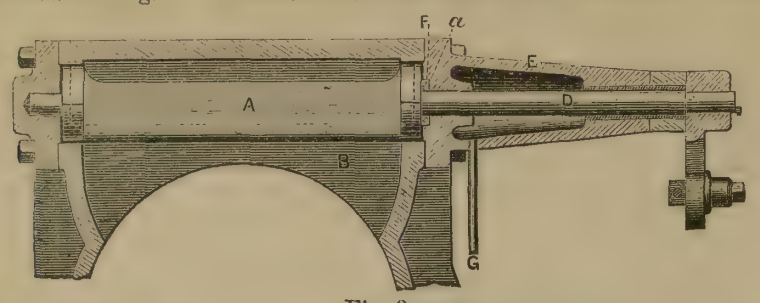


Fig. 3.

of the cylinder, rendering stuffing-boxes entirely unnecessary, and abolishing the heavy cast iron brackets, causes the collar to bear directly against the inside face of the bonnet, E. In Fig. 3, D is the valve-stem, on which is shrunk the steel collar, F, the latter fitting into a recess (*a*), provided in the bonnet. The contacting faces of both the collar and the bonnet are carefully got up to a scraped joint, and are, from the conditions under which they work, both self-packing and self-lubricating. The collar is kept to its seat in the bonnet by the steam acting on an area equal to the sectional area of the valve-stem, which is sufficient to ensure a proper working fit without entailing undue friction. The whole conditions are here the most favorable to prevent wear, since the pressure of contact is not great, the area of contact proportioned to the duty, and the lubrication is ample and continuous. Near the base the bonnet is cast hollow, which serves to lighten the casting and to receive drip, which is carried off by the pipe, G.

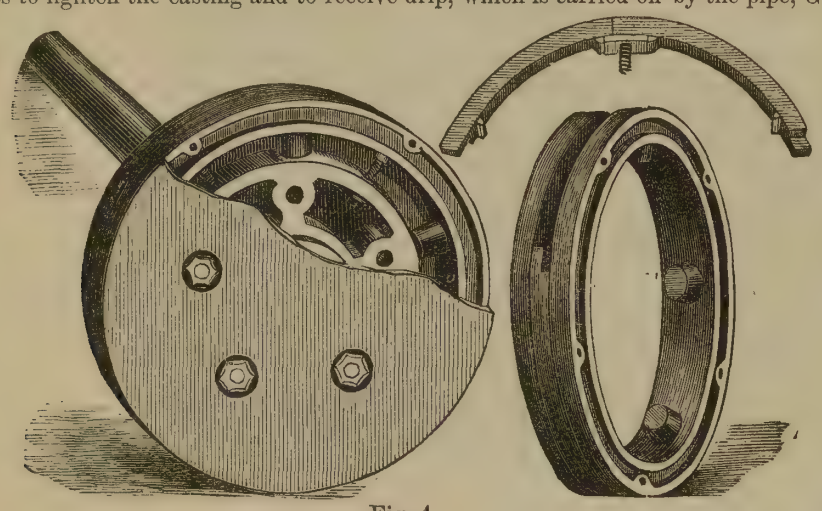


Fig. 4.

The second improvement is in the piston-head, the packing-ring of which, as shown in our engraving at Fig. 4, is put in in segments set out to fit the bore of the cylinder, by German-silver spiral springs, evenly all around; and is therefore an accurate fit, with an equal amount of contact at all parts, thus avoiding the tendency of ordinary packing to wear most near the split of the ring, and to wear the cylinder oval. The springs referred to, being of German-silver, possess this advantage: that they will not lose their tension from exposure to the temperature of the steam; and they are exempt from the corrosion so destructive to steel springs. Since the packing-ring is not set out by the steam, its contact with the bore of the cylinder is uniform, avoiding those variations in the fit of the rings to the bore of the cylinder, which would otherwise occur by reason of variations in the steam pressure; hence the wear is reduced to that only which is irreparable from a degree of contact, between the ring and the bore of the cylinder, sufficient to make a steam-tight fit. The piston-ring is carried in a groove in a chunk-ring; there being, between the sides of the ring and those sides of the groove, clearance to the amount of from 1-32 to 1-50 of an inch, permitting to the ring segments sufficient lateral movement when the steam strikes them on either side, to ensure equal wear and a continuously steam-tight fit. In fact, engines having this packing have had one valve disconnected and the piston run with steam on one side only, without a sign of leakage, through the piston, throughout a whole day. Another advantage of this improvement is that, by means of brass adjusting screws, the engineer is enabled to set and retain the piston rod in the centre of the cylinder. There is so small a portion of the thickness of the piston-head occupied by the packing-ring, that the piston has an unusually large amount of bearing surface on the bottom of the cylinder in horizontal engines; the effect being to reduce the tendency to wear the cylinder oval, and to obviate the cutting and abrading so common to pistons having a narrow surface.

The general arrangement of the engine is as follows: a truncated frame connects the inside cylinder-head to the pillow block. The valve gear is operated by a single eccentric. There are two steam-valves, one at each end of the cylinder, and placed as near to the bore of the cylinder as it is practicable to get them; thus avoiding the loss of steam due to the contents of long passages. The same valve admits and cuts off the steam, being actuated in its point of cut-off direct from the governor.

The introduction of these engines has caused an entire revolution in the design of the better class of stationary engines. In the old styles of engine, any change in the amount of the load was rectified by the governor in a very indirect manner. Thus the engine having, from a sudden decrease in its load, attained an undue speed, the governor reduced the supply of steam from the boiler to the steam-chest by throttling, or in other words, wiredrawing it. The defect inherent to this system, and hence to all simple slide-valve engines, is that the steam contained in the steam-chest is at its normal pressure, and forms, therefore, a reservoir of full pressure steam ready when the live steam port opens, to supply to the cylinder steam of a full pressure, irrespective of the fact that the engine is running away. The action of the engine governor, then, is always being counteracted by the steam in the steam chest, because, if we reverse the order of things, and suppose the engine to be running too slow, and the throttle-valve to be wide open, the constant and large draft of the cylinder upon the steam in the chest prevents the instant increase of the pressure in the latter necessary to insure regularity of the engine speed. Thus we find that there existed necessarily a certain amount of time between the action of the governor and its effect upon the engine; and that the length of duration of this time depended upon the size of the steam chest and other similar considerations. Another and important consideration is that reducing the pressure on the steam chest, the temperature of the chest valves, etc., as well as that of the cylinder piston, etc., ensued; and upon admitting live steam of a higher pressure and temperature an undue amount of condensation took place until such time as the temperature of those parts was restored. If a large steam chest were used, so as to obtain an initial pressure nearly approximating to that in the boiler, the action of the governor was the more largely counteracted by the existence of so large a reservoir of steam, whereas if a small steam chest was used, the fluctuations of temperature, and therefore the condensation, became the greater.

In the Harris-Corliss engine the action of the governor takes a short cut, by regulating the supply of steam to the cylinder through the medium of the induction valves, and altogether independent of the steam pressure in the steam chest, which latter is always filled with steam at the full normal pressure, thus avoiding fluctuations in both temperature and pressure, and communicating instantly the action of the governor to the cylinder steam supply, and ensuring a regularity of engine speed previously unattainable.

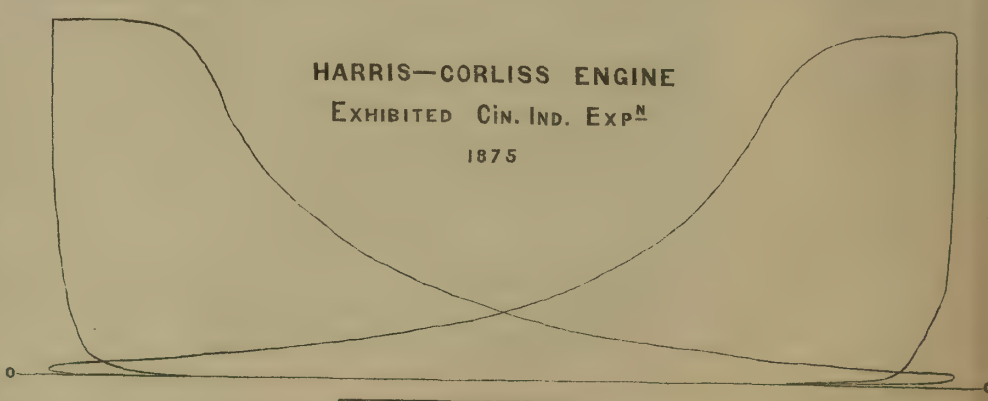
Thus far we have considered the value of this arrangement, so far as securing regularity of speed only is concerned, and we have now to regard the question of economy.

In non-condensing engines the utmost economy is attained when the steam is exhausted at a pressure but little above that of the atmosphere; hence in designing such an engine, its dimensions should be so proportioned that, when performing the lightest amount of duty it is intended to perform, the exhaust should take place at about that pressure; that is to say, the cut-off should take place sufficiently early in the stroke to ensure the necessary amount of expansion. To enable, however, the engine to perform the heaviest amount of duty, the valve arrangement should be such as to permit the steam to follow the piston as great a portion of the stroke as the engine duty demands; and this is precisely the action of the Harris-Corliss, for the degree of expansion increases in precise and immediate ratio as the amount of the load decreases the load or duty of the engine; not only governing the speed of the engine, as already explained, but accomplishing this end by regulating the point of cut-off, thus securing uniformity of engine speed and the most economic known means, *i. e.* increasing the expansive action of the steam. To these important advantages are due the successful operation and reputation of these engines.

The operation of the wrist plate and valve-rods at side of the cylinder is to accelerate or retard the effect of the movement of the eccentric upon the valves; so that while the eccentric revolves steadily, the valves shall move at the various parts of the stroke at just such a speed as practice has demonstrated to be the most advantageous. The whole of these valve movements are regulated from the one wrist-plate; hence the device is exceedingly simple and easy to manage. All the working parts are in plain view of the engineer, very accessible, and, being made to standard sizes, repairs are very easily and readily effected. The exhaust ports are at the bottom of the cylinder, and hence, carry off any water due to condensed steam. The exhaust valves are operated from the same wrist-plate as are the steam-valves, both having circular seat faces. Special tools are employed in the manufacture of the engine, and all the small parts are interchangeable, which makes it convenient for repairs, and for the construction of new work, *on short notice.*

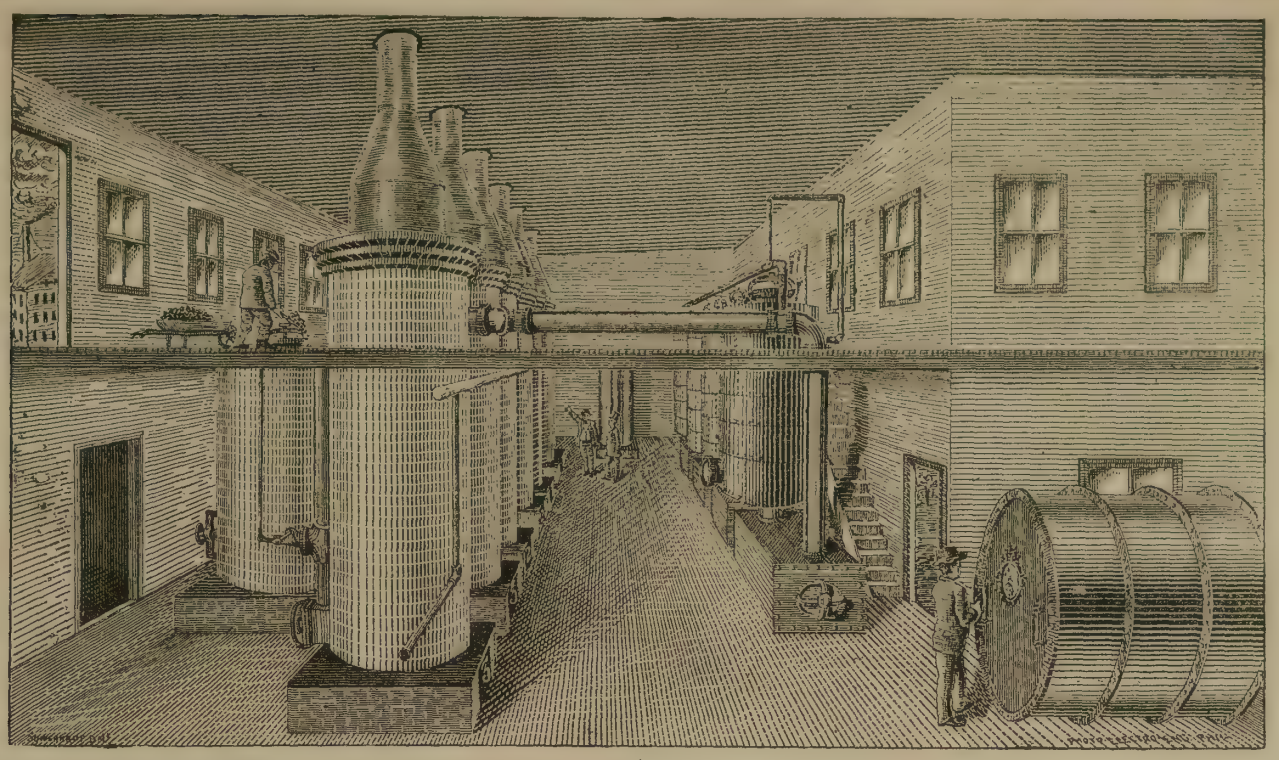
The Harris-Corliss Engine has taken gold medals at the Cincinnati Fairs of 1873, 1874 and 1875; and in the last named year it was awarded an additional premium of $300 in gold. It also obtained the first premium at the American Institute Fair, in 1869. The workmanship on these engines has always attracted attention, and has been a subject of remark in the English engineering newspapers. The engine is not exhibited at the Centennial, for the reason that an arrangement satisfactory to its builder could not be arrived at.

Below we present a diagram taken from the Harris-Corliss Engine, exhibited at the Cincinnati Industrial Exhibition, of 1875. It will be observed that the expansion curves are very perfect, as also are the exhausts, which are not only free from back pressure, but are unusually equal and even; a remark which also applies to the lead and admission lines.



FIRES IN SPAIN—A very intelligent Spanish subscriber remarked, in response to a query concerning Fire Engines in Spain, that "in our country we have no fires, *because we have no insurance companies!*" The moral is short and practical:—that fear begets care.

SUBSCRIBERS should remember that every additional name which is added to our subscription list, enables us to give a somewhat better paper.



THE LOWE GAS PROCESS AT MANAYUNK.

The history of the efforts to economize the gases produced by the decomposition of water in the manufacture of illuminating gas, and which for the past sixty years or more have been persistently made, have, until quite lately, been so uniformly unsuccessful, promising so much but fulfilling so little, that the great majority of gas experts had arrived at the conclusion that from some fallacious premiss in their proposition, the logic of the advocates of water-gas was radically false, and their hopes, impossible of realization. Within the past few years, however, a marked change has been brought about in the opinions of many who were the most strenuous opponents of the "*ignis fatuus*" of water gas, as the general incredulity had caused it to be proverbially designated. And now, the tide has turned the other way. The problem has been solved; and solved, too, in a fashion so practical and satisfactory, that opposition is virtually disarmed, and prejudice almost silenced.

The foregoing remarks have special reference to the Lowe Water Gas Process, in view of its recent record at the Manayunk station of the Philadelphia Gas Trust, where it has lately been introduced. In the February issue of the REVIEW, we devoted some space to a description of the system in question, commenting in favorable terms upon the system in general, and quoting the flattering opinions in regard to it, by Prof. Wurtz, who after a thorough investigation of the process as operated at Utica, N. Y., expressed the most decided convictions of its practicability and future capabilities. Since the appearance of the article in question, the establishment of a Lowe plant at Manayunk, upon a much larger scale than had previously been attempted, has afforded those who are interested in this subject, a further and more favorable opportunity of estimating its practical value, and the result may be summoned up briefly in the statement that it has been completely successful.

The following points, from the history of the Lowe process, will be found of interest.

The "Lowe Water-Gas Process" was first introduced in the working scale at the town of Phœnixville, Penna., some three years ago. These works have been in operation, without interruption for repairs or other causes, from the date of going into operation to the present time, supplying in summer about 5,000, and in winter 10,000, cubic feet of gas per day. The experience at Phœnixville demonstrated, to the complete satisfaction of those interested, that the product of the Lowe process was no more liable to stratification and condensation than the product of ordinary coal-gas works—one of the gravest objections that water-gas systems have had to meet. The system was next introduced at Conshohocken, Penna., some two years ago, where up to the present time, it has been in satisfactory operation, supplying in summer some 6,000 cubic feet, and in winter about 12,000 cubic feet of gas per day. The efficiency of the Conshohocken plant will be best appreciated when it is stated that, from the date of starting the works, *one* man has made all the gas, collected all the bills, attended to all the service pipes and meters, and has not been employed at the works more than three hours of each day.

Shortly after the completion of the Conshohocken plant, works were erected on the Lowe system at Columbia, Penna., and up to this time have been producing from 22,000 to 25,000 cubic feet daily.

The Lowe Gas Works, at Utica, N. Y., a city of some 30,000 inhabitants, built in the year 1874, were the largest that had up to that time been erected. Their capacity was over 200,000 cubic feet daily. The actual production for a number of months, until the unfortunate destruction of the works by fire, was about 120,000 cubic feet daily, representing a total production from April, 1874, to January, 1875, of 21,000,000 c. f. The works in question were erected hurriedly, to meet the terms of a contract, and at a season of the year when the erection of a permanent structure was impossible. In consequence thereof, they were built largely of wood. The inopportune destruction of the Utica plant was the subject of much regret at the time of its occurrence, for the performance of the works had been so remarkably successful as to have attracted the attention of professional gas-engineers throughout the country. The technical papers at the time teemed with glowing accounts of the successful solution of the "water-gas problem," and the leading gas chemist of the country, after a thorough examination of the process and product, gave the system his unqualified approval in a report of a most exhaustive character.* The Utica works, nevertheless, were sufficiently long in operation to demonstrate the perfect adaptability of the Lowe system for the production of illuminating gas of high quality upon the largest scale, and to secure for it the distinction of being a thoroughly practical solution of the "water-gas problem," which a generation of inventors had been vainly striving to attain. It is affirmed, at the time of this writing, that the works will be promptly rebuilt.

Within the present year, the Lowe system has been introduced at Dobson's Mills, (Falls of Schuylkill), Stroudsburg, Penna.; Clyde, and Fortplain, New York, and at Manayunk, a suburb of Philadelphia.

At Kingston, Canada, works are at present in course of erection, and the company under whose efficient management the Lowe process has reached its present successful attitude, has effected contracts for the building of works at the cities of Lancaster and Harrisburg in Pennsylvania, Trenton in New Jersey, and Baltimore in Maryland.

The Lowe Gas Works at Manayunk, with which we are here especially concerned, were built as test works. They were completed during the summer of the present year and went into operation on the 4th of August.

The plant consists essentially of three generators (of which at present but two are used), and six superheaters, three of which are used for superheating steam and three for fixing the gas. The other portions of the plant, condensers, purifiers, &c., will require no special mention. The generators are 10 feet 6 inches in height, and have an internal diameter of 40 inches. The superheaters are 15 feet in height, and have an internal diameter of 34 inches. Both generators and superheaters are very solidly constructed of fire-brick, and have double wrought iron walls, with an intervening air space. Generators, superheaters, condensers, scrubbers and station meter are all contained within a building 27×57 feet. The capacity of the new works is estimated to be 350,000 cubic feet; but up to the present time, they have been producing from two of the generators, worked only to one-half of their capacity for production, about 150,000 cubic feet daily, and having an average illuminating power of 19 to 21 candles. (Photometric tests of the gas made in several successive heats, during a recent visit of the writer, indicated an average illuminating power of 20 candles.)

The experienced observer, in examining the works in question, will be struck at once with two facts, namely, the great compactness and simplicity of the plant, and the surprising rapidity with which gas of excellent illuminating power is produced. These points will be best illustrated by the following comparison:

The old works (the usual coal-gas plant) occupied, with all their necessary appurtenances, about an acre and a half of ground. The retort house (109 feet long by 33½ feet wide) was furnished with ten benches of threes, and when worked continuously to their full capacity, could produce about 5000 cubic feet of gas per hour, a quantity not sufficient to supply the local requirement, and the deficiency was supplied by running into the holder an additional supply from the Market Street works.

The new works occupy scarcely one-tenth of the space of the old (the essential portions of the plant, as before remarked, being included in a building 27×57 feet). They are not run up beyond one-half of their capacity, and are supplying on an average 150,000 cubic feet of 20-candle gas daily, quite enough to meet local requirements, and employ the services of but seven men, three on the night shift, and four during the day. The results obtained, although highly satisfactory, and extremely gratifying to progressive gas engineers, are, however, by no means as complete as possible. The greatest economy in cost of production will naturally be found when the works are running up to full capacity, which at present, as before observed, is not the case. Furthermore, for economy's sake, portions of the old plant have been retained. This is notably the case with the boilers, which are located at a distance of 100 feet from the present generator house. In consequence of this, the pressure before the steam reaches the generators is materially reduced, entering the same wet, injuriously affecting the fires, and materially interfering with the complete decomposition of the steam, and the uniform production of water-gas. The lowering by this means of the high heat which should exist in the generators is attended likewise by an increase in the amount of carbonic acid formed therein. To meet these difficulties, the plan was tried, with excellent results, of employing the unused superheaters to superheat the steam, an expedient which with the proper arrangement of boilers in close proximity to the generators, would be rendered unnecessary. This improvement, as well as others, looking to greater convenience and economy in production, the managers intend shortly to introduce. The ac-

* *Vide* the *Engineering and Mining Journal*, xx, 502 *et seq.*; also this Journal, i, 2 *et seq.*

companying engraving will afford the reader a general view of the interior arrangement of the generator house.

For the operation of the system, we must refer the reader to our previous article on the "Lowe Process,"* and to the sectional view of the apparatus with description which appears upon our cover page. At Manayunk the two generators and three superheaters are so alternated thatt while one set is employed in generating and fixing gas, the other pair is being blown up preparatory to a charge. The duration of an operation is about thirty minutes. The average run of each set is from 6,000 to 6,500 cubic feet in the period named, but this volume has frequently been greatly exceeded and single runs on one set of apparatus have given as much as 13,500 cubic feet in thirty-five minutes. The cost of the 20-candle gas delivered into the holder, inclusive of labor, and interest on the investment, is admitted by the managers to be about 35 to 40 per cent. less than that of coal gas of sixteen candle power supplied to the city. This estimate at the present high price of petroleum will certainly be reduced when oil is cheaper. The quantity of oil supplied to the generators is gauged to flow at such a rate that about three gallons of oil shall be supplied, to the one thousand cubic feet of gas made. This quantity has been found by experience to be about the best proportion, when the heats are right, for making gas of twenty-candle power. Up to the present time the Manayunk works have been in operation without the slightest interruption from the date of starting, and have supplied about 10,000,000 cubic feet of gas.

We shall present some further considerations upon this interesting subject, in our next week's issue. W.

FAIR AND OPEN DEALING—Advertisers have the privilege of inspecting our subscription and advertising books at any time, that they may satisfy themselves concerning the size, character, and direction of our circulation. We could name a few of our cotemporaries, of the puffing class (and a few also more reputable), that lay claim to large or influential circulation, and whose circulation, as they say, "is *their* business." The number of copies that *we* print, the number of these in our subscription lists, the number sold by news-stands, and the number sold to parties interested in articles which appear in our columns—we consider to be our advertisers' business; as also, no less, are the questions of *who* read our paper, and in what sections they live and buy.

IMPERISHABLE AND FIRE-PROOF SHINGLES.

Mr. G. B. Smith, of Philadelphia, whose name will be familiar to many of our readers throughout the country, as the inventor of a very practical hydraulic system of injecting timber with preservative liquids, has lately devised, and, we are informed, has effected arrangements for practically introducing, upon a large scale, an extremely simple and excellent process for impregnating shingles with antiseptic and non-combustible substances, the immediate object of the process being to prevent the destruction of shingles by rot, and to render them proof against fire under all ordinary contingencies. Concerning the great utility and value of a process of this kind, which will fulfil in practice the promises of its advocates, there can be no difference of opinion. Shingle roofs have always been extremely popular, as the enormous annual consumption of timber in their production indicates, but the advantages which they possess on the score of cheapness and excellence is materially affected by their liability to take fire at the slightest cause, and the rapidity with which they deteriorate, by decay and rot, under the influence of the weather.

The annual consumption of shingles in the United States at the present time may be safely estimated at about four thousand millions, of which, doubtless, not less than 75 per cent. are demanded to replace those destroyed by fire or rendered worthless by rot. It will therefore be apparent that these two elements of mortality entail upon the country at large an enormous annual loss in dollars and cents, to say nothing of the losses arising from the communication of fire to neighboring buildings, which in many instances may be directly traced to the same cause.

The expedients that have heretofore been practiced to obviate or lessen these dangers and disadvantages, consist mainly in the liberal employment of paints or whitewash, which, in addition to being expensive or troublesome, are only partially, or at best, temporarily effective. By the process which Mr. Smith employs, the shingles are submitted to the action of antiseptic and non-combustible chemicals until thorough saturation is effected. This treatment insures the effectual coagulation of whatever of the decomposable sap matters remain in the wood, and so completely impregnates the fibres with mineral matter, that their ignition from all ordinary causes of accidental fires, such as sparks from locomotives, flying cinders from burning buildings, etc., is rendered impossible. At the same time the texture of the shingles is rendered denser and harder. A burning chip of wood, or glowing coal, placed in contact with the surface of one of the prepared shingles will simply carbonize the wood, at the place of contact, but will not inflame it. As a preventive against fire, therefore, the process in question is obviously of great practical value. The removal or the conversion of any albuminous matters that may remain in the wood into insoluble compounds with the antiseptic chemicals employed, on the other hand, is an equally effectual and valuable preventive of rotting. Upon these points Dr. F. A. Genth, whose position as the leading chemical authority in this country is undisputed, gives the following brief but decided endorsement, to wit:—

"The chemical ingredients which you use for preserving shingles, etc., and for rendering them fire-proof, are all powerful antiseptics, and will in every respect produce the desired effect. Shingles so treated must necessarily be very durable, and are not liable to ignite from sparks and flying cinders."

Other noted chemists are equally decided in their expressions of approval of the practical value of the process. The inventor has likewise secured the following endorsement of the fire insurance interest:—

"The inflammable nature of ordinary shingle roofs is such that we gladly welcome and endorse any improvement in their construction which tends to lessen the danger of fire communicating through them, as it is well known that disastrous conflagrations often occur from sparks or cinders falling upon them. Any method tending to obviate this danger should be speedily adopted, if it can be brought into use at a reasonable expense.

"From examinations made by us of specimens of your chemically prepared shingles, and from the opinions of scientific men familiar with the process of their preparations, we therefore cheerfully endorse their use on roofs and certify to an opinion that their employment in place of ordinary shingles would much diminish the danger of fire."

From the inventor's published statement, the cost of the prepared shingles will not prove to be an objection against their general introduction, but will on the other hand prove to be one of their strongest claims to public favor. At the present time, the wood used for the better (because more lasting) qualities of shingles, is cypress or cedar, and requires to be carefully selected and seasoned, and are sold at a much higher price per thousand than the commoner sorts made from spruce, hemlock or pine. The process of Mr. Smith permits of the use of pine, spruce, hemlock, chestnut, poplar or other common sorts of wood, and by virtue of the imperishable and fire-proof qualities which it imparts to them, renders these materials more durable and vastly safer than the most expensive materials usually employed. The actual cost of the treatment is admitted to be quite small, and the prepared shingles are available to the public at a price notably cheaper than they are at present charged for the better grades of ordinary shingles; the inventor's statement being to the effect that they can be sold at a cost of about one-third the price of good cedar shingles. On the whole, we have no doubt that the process of Mr. Smith possesses great practical value, and believe that the general introduction of his impregnated shingles, which bids fair to speedily occur, would prove of very great advantage. Manufacturers of shingles and others interested, can obtain all necessary information by communicating with G. B. Smith, 719 Sansom Street, Philadelphia. W.

ROUGH RIDING.

Travelers in primitive countries frequently complain of the roughness of the roads and the discomfort of the vehicles; and we may really consider one test or proof of civilization and advancement, to be the speed and ease of riding. Judging according to this criterion, we can hardly, in most of our American cities, boast of any wonderful advancement; and some of our cobble-roads, and even of our iron tracks, would relegate us at once to a condition of barbarism.

Let us consider our ordinary roads. We find in them neither that levelness and smoothness conducive to perfect traction, nor that moderate roughness favorable to foot-hold of the horses. The cobble pavement is constructed of stones, no two alike, bedded in yielding material in which each stone sinks to a degree dependent upon its size and shape. To the hoof of the horse this surface affords a succession of slipping places, wrenching his joints and lessening his power of draft. The wheels, at a moderate speed, slide and twist round among the rocky valleys; and when in rapid motion, perform a series of acrobatic feats, in jumping from summit to pinnacle, well calculated to weaken the felloes, wrench the axles, and retard the traction; while affording a jolting and chattering to the rider, and a noise to the neighborhood, commensurate with the rate of speed. The interstices between the cobbles are receptacles for filth which is alternately dust or mud, according to rapidly varying circumstances.

To escape the clattering and jolting of the ordinary carriage or hack, we take refuge in a street car. Here we find smoother traction, yet we are met by a vibration which keeps the windows in a constant tremor, and would cause our teeth to vibrate in synchronism did we not prevent it by clenching them. Reading is almost equally impossible as in the carriage; conversation is attended with similar difficulties. At each rail joint each wheel strikes the uptilted end of the next rail, with the effect of enabling one, knowing the length of the rails, to estimate the rate of travel, by counting the number of rail-joint concussions felt in a minute, over any one wheel. In starting, the horses slip on the cobbles, and lash out furiously when their smooth-shod feet seek for a "purchase" on the broad and worn flange of the rail.

Should a horse and carriage, whose driver has sought for an approximation to the desired smooth wheel-traction and unevenness of surface for hoof-purchase, be driven off the railway track, the wheels, instead of mounting the rail at once and crossing away from the track, "skid" along the flanges, with a screeching sound, and a wrenching of the axles, before accomplishing the feat. We hear that "Jordan is a hard road to travel;" our city streets can scarcely be better. The writer cannot see that, judged in accordance with our opportunities and our claims, we have any reason to be proud of our roads and vehicles. In a former article* we laid down the *desiderata* of a perfect road; the foregoing lines are designed to call attention to the roughness of our city riding, and to show how *very* far our highways are from fulfilling the conditions of comfort and economy in travel. G.

* *Vide* this Journal, i, 2 *et seq.*

* *Vide* POLYTECHNIC REVIEW, Vol. i, No. 1.

IMPROVEMENTS IN THE ART OF BELT MAKING.

[For the engravings and descriptive matter following, we are indebted to the Page Belting Co., of Concord, N. H.—EDS.]

Until a comparatively recent date, belting of any kind has been used but very little for the transmission of power, the common practice being the employment of large and ponderous upright and horizontal shafts, of either cast or wrought iron, and heavy trains of cog wheels of cast-iron or partly of iron and partly of wood.

The substitution of pulleys and belting in a small way, dates back one hundred years; but "for a long time" it was met by the prejudice of many engineers and mill owners who considered it an experiment of very doubtful result. The change from gears to belting has been a slow one, so slow that a few mills have not yet adopted the new plan. Aside from these exceptional cases, however, belting is now the well-nigh universal means of transmitting power. Still it was not until recently that the demand was sufficient to make the manufacture of leather belting a distinct and prominent business. Formerly, mill owners purchased the leather from the tanner, and made their own belting. The leather might be very good, but the want of proper machinery and the lack of skill, necessarily resulted in a poorly made belt. This practice of making one's own belts did not in the past, and does not, where it exists at the present time, constitute a business.

Leaving, then, those who merely make belting for their own use, we have had, growing up with the demand, two classes of manufacturers engaged in the *belting business*. One class, at first represented by few, but now, by many small establishments, purchase the leather from the tanner or merchant, and, like the mill owners above mentioned, make that leather into belts. But there is this difference: better machinery and more skill are employed. At present, in some manufactories of this class, the facilities for the work done are good; and the belting produced is of very good quality. But, when carried on in this way, the business is by no means complete. That establishment which attains the highest degree of success must begin with the green hide, and conduct the whole process of manufacture to the finished belt. By this complete process not only is there a large saving in cost, but a better quality of goods is produced than when the business is divided between the tanner in one place and the man who in another place makes the leather into belting.

It is in this complete business that we purpose to show the improvements that have been made in its past history; and, that these improvements may be made the plainer, we invite attention to the contrast between "the old way" and "the new way."

Fig. 1.—OLD FASHIONED TANNERY AND BELT FACTORY.

The Old Way. The green hides were first soaked in the little creek, to remove whatever of blood and salt there might be, and to soften any dry spots. Near by this creek is seen a vat, where the hides were immersed in strong "lime water," for the purpose of loosening the hair. A workman close by is removing the hair, the hide being thrown over one-half of a hollow log, called a beam. This beam is propped up at one end by a wooden horse. The hair being removed, the creek is again used to soak the lime from the hide, after which the beaming operation is repeated.

The few pits shown in the centre foreground constitute the tannery proper. Here, after a process of handling to secure uniform color, the hides were "salted" down with ground bark, and the vat then filled with water. The tanner is seen engaged in this operation, the hides near him on one side, and the basket of ground bark on the other side. On the right is seen the old fashioned bark mill. The ponderous mill-stone rolling round on edge was a tedious and expensive process of grinding the bark. This was all the power used in the entire establishment. The whole is a very good illustration of tanning, as carried on years ago. The work being done in the open air, this part of the business was confined to the warmer months. The process was a slow one; and much work was required to do a small business, which, but for the low prices of hides, bark and labor, would have made a high cost leather.

The shop was used for the "currying" of the tanned leather. This was done mainly in the winter, the leather having been dried out from the vats, as shown hanging on the poles and the adjacent fences.

Fig. 2.—OLD STYLE OF SCOURING, SETTING & FINISHING.

In this tannery no one kind of leather was made a *specialty*. Heavy and light hides were tanned together. Before the currying took place the leather was sorted. Some of the heavy was finished for harness leather; and a little was reserved for belting.

The dried leather was first thoroughly soaked in water, and then subjected to the process of scouring, as shown above. This consisted of working upon it with stones until the "grain" was soft and smooth; and the texture of the whole was well cleaned of much in it that would be injurious to the finished leather. It was a slow and laborious operation, especially when employed on leather designed for belting. The same kind and nearly the same amount of work had to be expended later in the currying process, when what is known as the "setting" took place. This was after the leather had been greased and partly dried. And again, still later, one man in the same manner would spend no little time in polishing the surface with a glass, unless, as was sometimes the case, the leather was allowed to go without a finish.

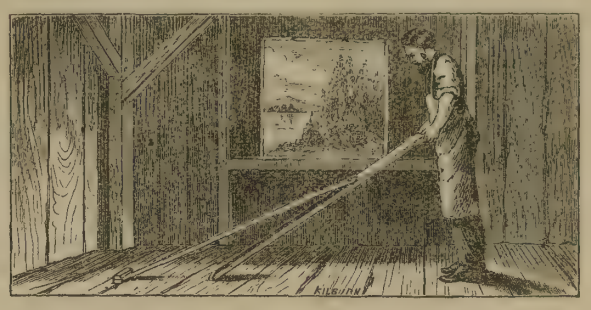


Fig. 3.—OLD STYLE OF STRETCHING.

In the same shop was also carried on the manufacture of belting. The first process in this part of the business was the stretching of the leather after being cut into strips. This process is shown in Fig. 3, which explains itself. By this process the leather was not subjected to more than a very moderate strain.

The leather was then cut with a straight edge into the widths desired, when the laps or splices were made by means of a common wood shave, the leather being held on an inclined plank.

Fig. 4.—OLD STYLE OF FITTING SPLICES.

The laps thus prepared were joined by applying glue to the connecting surfaces, when they were placed together, and the lap thus formed was constantly hammered over its entire surface until the glue had "set" or was dry, an operation requiring no small amount of time for each joint of even small belts, while the making of large belts was very slow indeed. Sometimes belting was made without laps, the ends of the strips being held together by means of thongs or laces.

Fig. 5.—OLD STYLE OF MAKING LAPS.

The belts made in the early history of the business, in the manner described, were very defective in quality of workmanship. They were liable to run very "crooked," from want of proper methods of stretching. The poorly made and bungling laps worked badly as they came in contact with the pulleys, and early gave out at the glueing. They were entirely lacking in beauty and finish.

(*To be continued.*)

THE BEST WORKMEN.—We have obtained from several hundred of our leading shops throughout the country, the names of their most expert workmen. To these the POLYTECHNIC REVIEW is sent free of all charge, as a *premium for good workmanship*. Their names constitute an honorable roll; and we congratulate those thus especially commended by their employers.

20,000 CIRCULATION!—All our efforts are bent upon attaining, before the lapse of many months, the circulation indicated; and in so placing that circulation among *consumers* of manufactured products, as to render those 20,000 copies of tenfold more practical value to our advertisers than that number going to pupils, farmers, employés and other non-purchasing classes.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

A New Light Draft Propeller, built by George Chaffey & Bro., Portsmouth, Ontario, and illustrated in the *Scientific American* of 21st inst., is 103 ft. long over all, 20 ft. beam on deck, draft forward 3 ft. 6 in.; aft, 4 ft. 4 in.; accommodates in her forward deck 50 head of cattle, and in her cabins and on the upper deck, 400 passengers; has an inverted single cylinder high-pressure engine, 14″×13″ stroke, with steel rods, crosshead and shaft. There is a Lowmoor iron return tubular boiler, 9′ 3″ long, 9′ high, 5′ diameter, and containing 157 return tubes each 2½″ by 7′ long. Consumption of anthracite, 1½ ton per 100 miles. "Chaffey" propeller wheel, 4′ 4″ diam. 7′ 6″ pitch. On the trial trip of 2¼ miles, 14.2 miles per hour were made, the engine making 208 revolutions with 100 lbs. of steam. 15 miles per hour are now claimed; and it is stated that she does not settle aft at high speed, as is ordinarily the case with screw steamers, when running fast.

A New Steam Brake (patented by T. J. Shellhorn, Marquette, Mich.,) has between the wheels to be braked, a steam cylinder, with two pistons and rods, one attached, by levers, to each brake shoe. Steam admitted between the pistons applies the brakes; volute springs between the piston and heads releases them when the pressure is withdrawn and the exhaust opened.

Locomotive for Inclined Rail Roads. Messrs. Copeland & Bacon, of N. Y., have constructed, under supervision of Mr. H. C. Walters and from his designs, a locomotive for inclined railroads. The engine stands upon an open platform and is worked by means of a strong wire rope which runs from one end of the track to another, making several turns around two large drums of the engine, one above the other, the upper drum being connected with the steam power by means of a huge cog-wheel. The track on which the locomotive is now being tested rises one foot in ten, and the machine will do even better than that. Six of these locomotives are to be built for use on a couple of mountain roads—one near Salt Lake and the other near San Francisco. They are four miles long and very much curved, and do a freight and passenger business, connecting two railroads with each other. The locomotive works finely, going up hill or down with equal facility, and can be stopped anywhere on the steep plane without difficulty. When in actual use these engines will draw the cars up the hill and they will run down without assistance. [*R. W. Review*, xiii, 125].

New Street Car Design. The Missouri Car & Foundry Company, of St. Louis, has been building a horse-car of new design, for the Cass avenue street railway in that city. The roof resembles very much the roof of a Pullman car; the windows being much larger and higher than those in any other style of street car. At each end of the car under the roof is a window for ventilation, protected by a wire screen for excluding the dust. Cheney's patent brake is used, which is claimed to be the most powerful, effective, and economical brake yet invented. "It is applied to the axle and possesses the following advantages over the shoe brakes: There is no trouble or expense of putting on brake shoes, and no wear on the face or flange of wheels; it is entirely out of the way of snow, ice and mud; works equally well at all seasons, and gives the driver perfect control of his car; the friction, when applied, is exactly alike on all the wheels, so that one pair cannot revolve and the other remain set, thereby causing 'flat wheels;' and the car is easily stopped without setting any of the wheels; but, in case of emergency, all the wheels can be set and the car brought to a sudden stop. The brake is very simple, and occupies so little space that the largest size may be put on any car having a space of six inches between car floor and top of axle. The brake, if perfectly oiled (that being about the only attention required), we believe, will outlast the car itself, with comparatively no expense for repairs. These facts are not stated as a theory, but are proved by their use on the street railroads of Detroit, since October, 1874, and lately by their use in other cities both East and West."

The coupler is also a new design. A chair is used upon which the whippletree rests. The bolt is part of a long rod extending from an arm, in which a handle is joined to the rod; when the driver wishes to uncouple he raises the handle and the bolt rises with it. A door clasp is used which resembles Miller's car couplers. It is easily operated and very effective. The duplex car spring (combined rubber and steel volute) is used. They are secured between two wrought iron bars on each side of the wheel, forming a yoke—the whole being encased in a cylindrical casting of very attractive design. The car is lighted by an elegant center lamp suspended after the style used in steam cars. The lamp boxes at the ends of the cars are done away with. [*R. W. Review*, xiii, 125].

Telegraph Extension in Africa.—It is proposed to carry a wire to the Cape across the African continent. There is at present telegraphic communication from Alexandria to Khartoum, a distance of eleven hundred miles, and surveys have already been made for its continuance to Gondokora. From Khartoum to Delagoa Bay, where the South African lines terminate northward, is only about 2,600 miles shorter than existing lines on the other three continents. The route would lead under the Victoria Nyassa and Tanganyika lakes, and thence down the Shiré and Zambesi rivers to the sea, where a short ocean line would connect it with Delagoa Bay or Port Natal. A branch would go from Ujiji to Zanzibar. Of the 1500 miles or so of aerial line, it is suggested that much might be erected without the expense of poles by taking the advantage of the trees over thickly-wooded tracts, which are frequent in tropical Africa. The difficulty would be to keep the natives from utilizing the wire in regions where iron is scarce and valuable, but this might be got over. The undertaking, if it could be established and kept in working order, would be exceedingly lucrative, and would in many ways aid in opening up Africa to commerce and civilization. [*Iron*, viii, 421.]

Improved Mandrel or Core for Casting. By James M. Rohrer, Shamokin, Pa.—The flanges for holding the parts of the mandrel together are bored out tapering to fit the tapering ends of the shell, so as to be easily removed. The shell is cut longitudinally to receive a beveled key, which is cut beveling, so that it will give toward the center, as the shell contracts when the center plug is given from the shell to relieve the pressure caused by the shrinkage of the casting in cooling. This sectional mandrel is used in casting cylinders of any kind that require hard and smooth inner surfaces.

Improved Sawmill Dog. By Alfred Mepham, Fayette, Ohio.—This invention consists of a dog, mounted on a block, which slides up and down on the standard, with a crank pinion and toothed bar for working it, and a ratchet lever for applying great force to press the dog into the log. There is also a secondary plank dog detachably connected to the block carrying the principal log dog, and contrived with a cranked screw nut for drawing the plank up to the standard, in addition to the contrivance for pressing the dogs down into the timber.

Improved Locomotive Wheel. By Wilson Weathersbee, Spring Garden, Ill.—This is a new method of gearing one or both of the driving wheels of a locomotive, so that they can turn independently of each other in going around curves, and thus prevent sliding, as when both wheels are keyed fast to the axle.

Car Replacer. By Homer G. Brooks, Greenville, S. C.—This consists of a casting that rises gradually on an inclined plane from the broader lower part to the narrower higher end, at a level with the rail, being fitted thereto by bottom recesses and rail-head binding wings. Guide grooves and flanges lead the car wheel to a key, socketed at suitable angle at the highest end of the replacer, to transfer then the wheel to the rail.

MINING, METALLURGY AND MINERALOGY.

A Blast Furnace for the Reduction of Zinc from its ores. Mr. F. C. Clerc, chemist of the Lehigh Zinc Company, at the recent meeting of the American Institute of Mining Engineers, described a process and apparatus, for the continuous production of zinc, which attracted much attention. The desirability of a continuous process for the production of zinc is very great, and great interest is felt by metallurgists in the test trials of the Clerc furnace, which will shortly be made.

A New Cornish Mineral.—Mr. F. Field gives the following description of a highly crystallized and very beautiful Cornish mineral which is quite new to mineralogical science. Its crystallization appears to be rhombic; it is transparent and brilliant, of a clear green color; hardness about 3·5. It is perfectly soluble in dilute hydrochloric acid, forming a nearly colorless solution. On heating a little over 100° C., the crystals lose water, and at a low red heat at once become brilliantly black. They decrepitate strongly.

Analysis proved the existence of phosphoric acid, ferrous oxide, and water in the proportions that would lead to the formula—$3FeO, P_2O_5, 4H_2O$.

From the great scarcity of the mineral only small quantities can be obtained for analysis, and this brief description must be regarded merely as a preliminary note on a mineral of great beauty and interest. [*Chem. News*, xxxiv, 147.]

Vera Cruz, Mexico, is to have a rolling mill; Edward Gough, brass and iron founder, of Allentown, Pa., having just turned out six rolls for its equipment.

Boracic Acid in Iron Ores. Prof. Eggleston, in a paper read before the recent meeting of the American Institute of Mining Engineers, announced the fact that "certain Lake Superior iron ores are so completely filled with a borate, that it is not possible to find the smallest piece which does not contain certain white specks, which have proved to be a borate of lime and magnesia, and which is probably a new mineral." Prof. Eggleston thinks it possible that some boron from this source may find its way into the iron, and deems it probable that this fact may explain some of the peculiarities of Lake Superior iron.

—*The lead production* and consumption of this country are both rapidly increasing, while imports are decreasing. In 1866 the product was 14,342 tons; in 1875, 53,000; with imports in 1866 of 27,200 tons; in 1875, 11,000. The annual consumption of the United States is about 60,000 tons. A slight increase of production would give a surplus for exportation.

Venerite is the name proposed by Prof. T. S. Hunt for a peculiar earthy copper ore found (and utilized in considerable quantities) in Berks County, Penna.

The French Ironmasters, during the first half of this year, imported 414,625 tons of ironstone. Of this 188,000 tons came from Algeria, 76,000 tons from Spain, these quantities being much less than those of the preceding year.—*Cannel coal* is said to have been discovered in Greene county, Pa.—*The August* bullion product of the Comstock mines was as follows:

Belcher	200,000
California	1,793,700
Chollar-Potosi	47,000
Consolidated Imperial	77,800
Consolidated Virginia	328,000
Ophir	393,000

—*The first* shipment of California petroleum has just been made from the refinery at Ventura to San Francisco. [*Am. Manuf.* 10–19, 1876].

Guano. According to M. Habel, it is a mistake to suppose that the accumulation of guano on the islands Chincha consists of the excrements of sea-birds inhabiting these islands. In reality, it is composed of two strata, differing both in the mode and date of their origin. The upper stratum, far the smaller, is composed of the excrements and bodies of birds and seals now occupying these islands. The lower stratum took its commencement in pre-historic times from the excrements of birds, let fall to the bottom of the sea, only a limited portion of which was occupied by these birds. The stratum thus formed has been since raised (as still occurs in the present day) at the same time as the bottom of the sea, and the islands themselves are only the result of these upheavals. [*Technologist*, vii, 226].

CHEMISTRY, PHYSICS AND TECHNOLOGY.

To Remove Ink Marks from Paper without affecting the smoothness and gloss of the surface, it will be found sufficient in most cases to moisten the inked surface first with a solution of cyanide of potassium and then of oxalic acid. A camels-hair brush may be used to apply the two liquids, being dipped alternately in each until the marks have disappeared. [The *Papier Zeitung*, i, 300]

To Render Fabrics Waterproof.—M. Dujardin proposes for this purpose the following procedure. 335 grammes each of potash, alum and sugar of lead, are to be triturated in a mortar until the mass becomes syrupy, to which is then to be added 400 grammes of a mixture of equal parts of finely pulverised bicarbonate of potassa and sulphate of soda. To this mixture there should now be given about 50 litres (about 11 gallons) of rain water, and when complete solution is effected, the same is to be poured into a vessel containing an oleine soap in solution in an equal quantity of water. This mixture is to be stirred for about twenty minutes, or until complete mixture has occurred. To waterproof a fabric, it is necessary only to immerse it, with the hand or by mechanical means, into the aforesaid mixture, and to retain it there until by pressure or otherwise the fluid has penetrated to every portion of it. The fabric is then removed, and after allowing the surplus fluid it retains to drop off, hung up to dry. Afterwards it is thoroughly washed in cold water, and agained dried. Goods treated in this way, it is affirmed, are waterproof, but still permit free transmission of air. The colors of the goods are in no wise affected. [*Journal des Fabricants de Papier.*]

Waterproof Paper of superior quality, transparent and impervious to fat, may be prepared by saturating good paper with a liquid prepared by dissolving shellac at a moderate heat in a saturated solution of borax. Paper thus prepared resembles parchment, and may be given any color by the use of aniline dyes. [*New Remedies*, v, 320.]

New Uses for Vanadium.—It is affirmed by James Gibbon that paper drawn through a solution of a salt of vanadium and exposed to sun-light, will furnish a distinct image when treated with salts of uranium. He proposes a mixture of vanadium and silver salts, and the use of ferrous sulphate as a developer. The potassium salt of vanadic acid in contact with organic matter, aided by the influence of sun light, turns first green, then blue. These and other experiments show that only the scarcity of vanadium prevents its use for photographic purposes. [Abr. from *Industrie Blätter*, xiii, 198.]

NOTE.—The assumed scarcity of vanadium will hardly place an insuperable difficulty in the way of the industrial applications of this substance, should a decided demand for it arise, as would seem to be indicated in the foregoing item. Late investigations by Dr. Walz, for example, have established the fact that vanadium occurs very generally in American magnetic iron ores, and sometimes in quantities which are not inconsiderable. Prof. Blake has established its occurrence in considerable quantity in mica from California. Prof. Koenig has found it in a number of minerals from the Magnet Cave, Arkansas. Prof. Genth has just discovered two new vanadium minerals from California, and Prof. Hayes has shown vanadium to be very widely though sparsely distributed in porphyritic and slate rocks, natural waters, etc. In Europe, its wide occurrence in limonites, hematites, etc., has also been established.

Vanadium salts have already come into use in dyeing, in the manufacture of aniline black, and in the production of black ink (Boettger). There can be no doubt, from the foregoing statements, that should an increased demand for this substance arise, it could be produced in large quantities, and at a moderate cost.

Chloride of Lead prepared by the addition of nitrate of lead to a solution of common salt, is recommended by Dr. Goolden in the London *Lancet* as a disinfecting liquid.

Aniline Colors without Arsenic.—Coupier, of Paris, was the first to succeed in producing fuchsin by the action, at a suitable temperature, of hydrochloric acid and iron in small quantities on pure aniline and nitrotoluol.

Recently, the Gesellschaft für Anilin Fabrikation, of Berlin, has erected new works, where no arsenic is used in the preparation of colors. Not only fuchsin (rubin), but all the colors derived from it which are manufactured by this company, are warranted to be produced without the employment of arsenic, and to be entirely free from this poisonous reagent.

The Berlin company is working Coupier s process with several important modifications, and produces from 450 to 675 lbs. of fuchsin per day. Some specimens of fuchsin and other colors manufactured by this company appear to be products of unrivalled beauty, purity, and strength. The fuchsin is stated to be not only purer, but stronger than that made by the aid of arsenic acid, and is the pure hydrochlorate of rosaniline. The rosaniline base, from its great purity, is admirably adapted for the preparation of aniline blue, and is now being very largely used by other manufacturers of aniline colors.

Being free from arsenic, these dyes are not only fitted for coloring sweetmeats, liquors, syrups, and pharmaceutical preparations of every description, but may be used in many other industrial purposes where poisonous colors would be more or less dangerous, as in the staining of paper, paper hangings, toys, etc.

It is to be desired that other manufacturers of these dyes will adopt the new method, and relinquish the old arsenic acid process, which, apart from the inconvenience it has caused both manufacturers and consumers, has led to many lamentable accidents. [*Chemical News.*]

A Nebula-Photometer.—Prof. Pickering has devised a photometer to measure the intensity of any part of a nebula with a view of detecting changes of brightness The principal is that of Dove's photometer, which is somewhat similar to that of Bunsen, the essential feature being a small film of translucent collodion (on a glass plate) placed at the principal focus of the telescope, and illuminated in front by the light of the portion of the nebula under examination, and behind by a lamp, the intensity of which can be decreased at will by two crossed Nicol prisms, or in other ways. The light is thus varied till the spot of collodion disappears from the equality of the illumination on the two sides, and the brightness of that portion of the nebula is thus determined in terms of the lamp as a standard. The brightness of the sky must also be determined and subtracted from the result found for each portion of the nebula. [*Academy.*]

Improved Sugar Mill, by James Mallon, Baton Rouge, La.—This invention consists of a sugar mill, arranged with a perforated steam pipe in front of the receiving rollers, and one or more perforated steam-pipes in the cane knife for forcing small jets of steam up through the cane as it passes over the knife or turn plate. [*Sci. Am.* Oct. 21, 1876.]

Electric Light at Sea.—The electric lighting apparatus of the French Transatlantic Steamship *Amérique* consists mainly of a Gramme machine, a portable lamp and a signal light placed in the upper part of a sheet-iron turret. The Gramme magneto-electric machine has a power of two hundred carcel jets, while the lamp is fitted with prismatic lenses, and is capable of throwing a glare of brilliant white light over an arc of 225 degrees. The lamp on board the *Amérique* was thirty-three feet above the water, and at this hight it was thought to have a possible range of ten geographical miles for an observer stationed twenty feet above the water. Not only would such a range, or anything approaching it, tend greatly to reduce the risk of collision, but the powerful illumination was found available for loading or unloading operations, and was useful in guiding the vessel in and out of port, at night. As regards the movable lamp, a very important use was found for that. By means of a cone of sheet-iron placed over the light, with the broad base of the cone uppermost, a flood of light was thrown on the *Amérique's* topgallant sails, so that these might be seen by other vessels a long distance off, even apart from the signal light. It is further added that the whole apparatus is by no means expensive, is easily managed, but little liable to get out of order, and occupies but little room. [*Sci. Press*, xxxiii, 251.]

Etching on Glass.—Since fluoric preparations have been produced at reasonable prices, the decoration of glass by their means has steadily made its way. Etched glass is now to be found everywhere, and glass-etching runs glass-cutting very hard.

As it is well known, fluoric acid usually etches smooth, while other fluoric preparations yield a matt surface. The most beautiful ornamentation is obtained when certain parts of the glass surface are rendered matt by means of fluoride of ammonium which has been slightly acidified by means of acetic acid. The matt appearance is not always the same with different kinds of glass, but varies much in beauty; this effect is governed by the composition of the glass, lead glasses being easily acted upon, and furnishing a very fine matt surface.

Where it is desired to have the surface of the glass not altogether matt, but shining like ice, as in the case of window-glass, this may be attained in a simple manner by placing the plate in a perfectly horizontal position and covering it with fine groats. Then very dilute fluoric acid is poured upon it. The groats act as a shield, and produce upon the glass raised points.

Several ways exist of etching photographs on glass. A good result may be secured by covering the surface with a solution of gum, made sensitive with bichromate of potash, and printing the same under a negative; after the image has been thus produced, it is dusted over with minium or red lead, and the red picture thus obtained is fixed and burnt in the usual manner. The easily soluble red glass, so obtained, is treated with strong sulphuric acid, when a white matt is produced, and the picture appears by transmitted light as a positive. [*Photographisches Archiv.*]

MISCELLANEOUS.

"The Rank is but the Guinea's Stamp."—Herr Hofman, in his *Papier-Zeitung*, devotes some space to a denunciation of the practice that obtains amongst certain German makers of packing their goods in coverings with English or French titles, for the obvious purpose of palming them off upon the public as foreign wares. One paper maker, whose want of familiarity with English, led him into the blunder of inscribing on his packages, "Finest Leter Paper," comes in for a fine excoriation.

The foregoing would seem to indicate that even the German industrials are not above practicing certain questionable tricks of trade which we had supposed to be the peculiar prerogative of American manufacturers of certain classes of goods, which, since people *will* have none other, are, to gratify the innocent prejudice, sold as foreign made. After all, the sellers are not so much to blame as the buyers, whose foolish blindness to the excellence of home products, fosters this humiliating system of deception, to the disparagement of American industries.

We shall be greatly deceived, however, if the great Exhibition does not prove to be a wholesome educator of our people, in this regard, by affording them the ocular demonstration that there are but few provinces of industry in which America may not fairly compete in proficiency with foreign countries; and by hastening the extinction of that gradually diminishing class of Americans in whose vocabulary the designation "foreign," is the only synonym for excellence.

Shingles should be laid in courses which are *less* than one-third the length of the *shortest* shingles; if any poor ones be used, they should be near the upper part of the roof. Joints should not be "broken" within less than 1½" of each other.

Our foreign trade continues to show a gratifying balance in favor of this country. The following table, copied from the report of the Bureau of Statistics for July and for the seven months then ended, shows its condition in a clear and condensed form:

IMPORTS.

	Month ended July 31.		Seven months.	
	1876.	1875.	1876	1875.
Value of mdse	$30,539,474	$41,295,317	$262,942,257	$316,118,846
Gold and silver	983,107	1,129,634	6,305,761	13,402,755

DOMESTIC EXPORTS.

Gold value of mdse	$38,489,707	$36,449,930	$313,085,569	$282,727,282
Gold and silver	8,697,787	6,312,611	38,433,014	56,117,999

FOREIGN EXPORTS.

Value of mdse	$ 1,274,291	$1,168,121	$ 9,143 995	$ 7,919,086
Gold and silver	591,869	289,904	4,244,776	6,669,862

It will be seen from the above that the exports of domestic merchandise for the seven months ending July 31 exceeded the net imports of merchandise by $59,287,307.

The Position of Science in Modern Life.—Natural science is no longer content with the contemplative attitude which sufficed for Newton and Laplace. Science is now mixed up with all the personal acts of our existence; she interferes in all measures of public interest; industry owes to her its immense prosperity; agriculture is regenerated under her fostering care; commerce is forced to take her discoveries into account; the art of war has been transformed by her; politics is bound to admit her into its councils for the government of states. How could it be otherwise? Have not mechanics, physics, chemistry, the natural sciences, become intelligent and necessary agents for the creation of wealth by labor? If comfort is more universal, the life of man more prolonged, wealth better distributed, houses more commodious, furniture and clothing cheaper, the soldier better armed, the finances of the state more prosperous, is it not to the sciences that all this progress is due? . . . Whether we wish it or not, we must needs accept Science as a companion, to possess her or to be possessed by her. If you are ignorant, you are her slave; if you are skilled, she obeys you. The future belongs to science; unhappy are they who shut their eyes to this truth. [From the opening address of the President of the French Assoc. for the Adv. of Science, 1876.]

The Health of Philadelphia.—The Bureau of Medical Service of the Exhibition has published a circular showing that the average annual death rate in this city, from May 13th to September 23d, has been 23.48, against 30.73 in New York, 26.91 in Brooklyn, 24.80 in Baltimore, and 24.27 in Chicago, during the same time. The average mortality per week from typhoid fever and diarrhœal affections has been 83.88; from zymotic diseases, 112; from all causes, 406.5. Despite the very severe and prolonged heat of June and July, and the vast number of unacclimated strangers constantly present in Philadelphia since the 10th of May, the general health of the city has been remarkably favorable. With the exception of the four weeks ending July 22, the range of temperature for the past five months has been about the average. Thus, for the entire period of twenty weeks since May 10th, the mean daily temperature has been 71·30° F., while the average for the same months during the past ten years has been 71·82° F The mean temperature of the four weeks referred to (ending July 22d), on the other hand, was 80°, 83°, 83°, and 81° respectively, giving an average for the month of 81·75°, against 75·5° F., the mean temperature of the corresponding period of the previous year. [*Med. and Surg. Rep.* xxxv, 3487.]

Effects of Compressed Air on Animals.—The mechanical effects of compressed air upon the animal economy, as ascertained by Bert, are to cause a lowering of the diaphragm and liver, and a consequent increased pulmonary vital capacity; this effect, while gradual in its production, lasts long after the subject is withdrawn from the compressed air bath. Pravaz finds that the heart's action is at first increased, and then lessened, the pulse first becoming more rapid, and then slower, but never falling below the rate at normal pressure. The respirations are diminished during immersion, but on removal of the increased pressure they rise in frequency and in direct proportion to the degree of compression. There is an increase in the amount of urea excreted, but this increase diminishes the longer the sojourn in the compressed air. There is at the same time an increase in the amount of carbonic acid expired. The temperature of the body arises above the normal at first, and then falls as the immersion is prolonged. These varying effects are due, Pravaz thinks, to the two influences of inward atmospheric pressure and hyperoxygenation, the former tending to diminish the circulation and the organic changes, and the other to increase them. [*Popular Sci. Monthly*, x, 120]

—August Abadie has taken out a patent in France for improvement in the manufacture of paper by the introduction of sulphate of magnesia.

—A number of bibliographical notices have been held over or want of space.

CENTENNIAL NOTES.

The Hitchcock Gun is shown in the Government Building. One model shows the mode of laying around the steel core the wire which is brought from twelve drums and so wrapped at varying angles as to distribute the strains in every direction. A second model shows the mode of heating the gun and soldering the wire together.

Brown & Carver, Philadelphia, show at E–26 their paper cutting machine, in which the pressing table, which is raised and lowered by a hand wheel at the top of the machine, slides upon a vertical bar forming part of the frame. The presser consists of a number of vertical plates, several inches wide at the bottom; and strips only half an inch in width may be held and cut. A worm wheel and screw in front of the main table advances it by sixteenths of an inch. The knife has a diagonal motion or "draw-cut" given it by means of the fly wheel having one end of its spindle a pinion gearing into a spur-wheel with a slotted center, in which slides one end of the diagonal connecting rod attached to the knife. When the knife is dull a double gear is used.

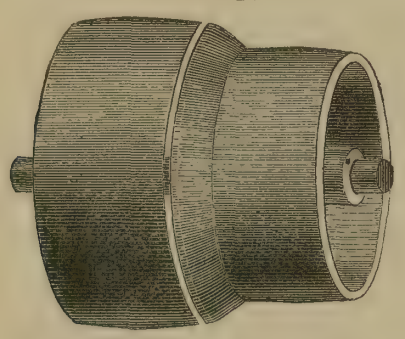
Howard & Bullough, of Accrington, England, show, as specimens of Lancaster cotton machinery, an intermediate frame, a drawing frame, and a carding engine. These are noteworthy from an electric device which stops the machine when the cotton breaks down; and in the carding engine rings a bell to notify the attendant.

Gimson & Coltman, show, in the British section, machines or knitting Cardigan jackets and sleeves, and half-hose; a dial on the latter indicating the amount of work done.

Sutcliffe's "Paragon" Middlings Purifier (British section) cleans the kernels from the husks of middlings, and sorts the former by sizes. There are revolving brushes which brush the material through silk sieves of gradually increasing coarseness.

J. & H. Gwynne, (of London, England,) show in the British section some beautiful models of their centrifugal pumping machinery, with compound surface condensing engines—representing one pair of four sets at Codingo, near Ferrara in Italy, and each of which originals raises 4,000 tons of water per minute.

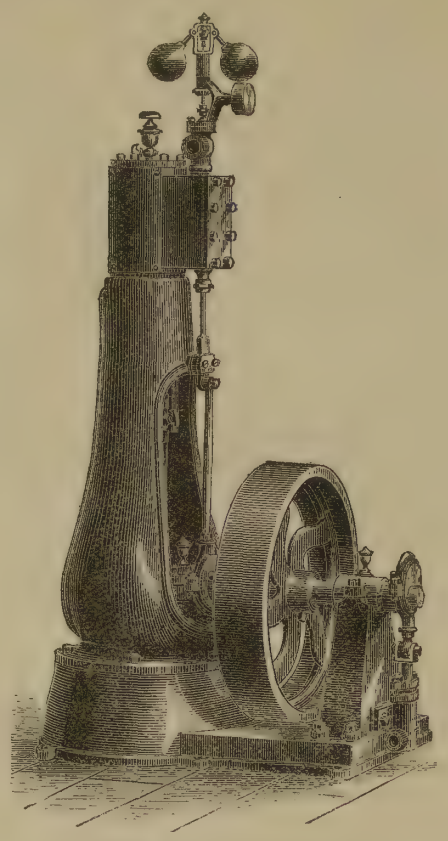
John Brown & Co., L't'd., and *C. Cammell & Co.,* (both of Sheffield, England) show, in the British section, heavy armor plates, which have been severely tested; one of the Messrs. Cammell's 11″ plates having been fired at with a Palliser chilled iron shot from a 7″ muzzle-loading rifled gun, with a charge of 18½ lbs. R. L. G. powder at 30 ft. range; the penetration being about 7 inches.



CRAFTS & FILBERT'S LOOSE PULLEY.

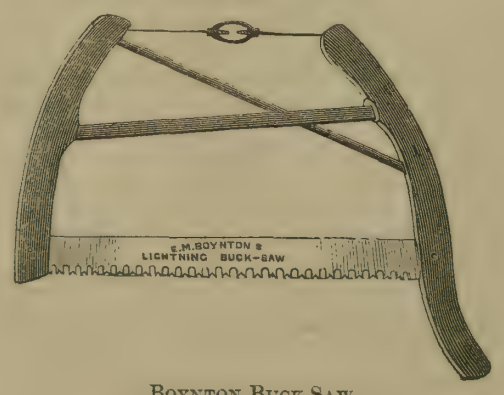
The loose pulley shown herewith, was patented February 29th, 1876. Connected with machinery run at a high rate of speed, loose pulleys have been a source of continued annoyance. They not only require constant attention, but are hard on the belt, and take much oil. The cut represents the loose pulley two inches smaller than the tight pulley, and provided with a conical flange for the belt to run up on. The difference between the pulleys will slacken up the belt three inches, taking the strain off the belt and the friction from the pulley; and allowing the belt to contract, when thrown off the tight pulley for the night. The belt has a change to give and take, as it is always in a slack condition when on the loose pulley, and should contract enough to keep it tight for a long period; and anything that will take the strain off the belt is certainly adding to its durability. There is considerable wear and tear on a belt in shifting it with the ordinary pulley. In starting a heavy machine it is necessary to hold the belt on with the shifter until the machine is under full headway. During that time the edge of the belt is rubbing against the shifter, tearing up the corners of the laps, and wearing away the edge of the belt. But the flanged pulley should require very little aid from the shifter. When the belt touches the flange it immediately climbs to the tight pulley, and remains there—starting the machine quickly.

This pulley is running on Houston's, Power and Tainter's, and Smith's machines at the Centennial, and is made by Crafts & Filbert, Williamsport, Pa.



TWISS VERTICAL ENGINES.

Nelson W. Twiss, of New Haven, Conn., exhibits, at C–79, vertical engines, two types of which are shown in the cuts annexed. They have no specially distinguishing features in plan; but for design, lightness, strength, and good workmanship, deserve commendation.



BOYNTON BUCK SAW.

The cut shows a Boynton Buck Saw, with the M or "Lightning" tooth, and a frame so braced as to give great rigidity and the capacity to take in a log of greater diameter than usual.

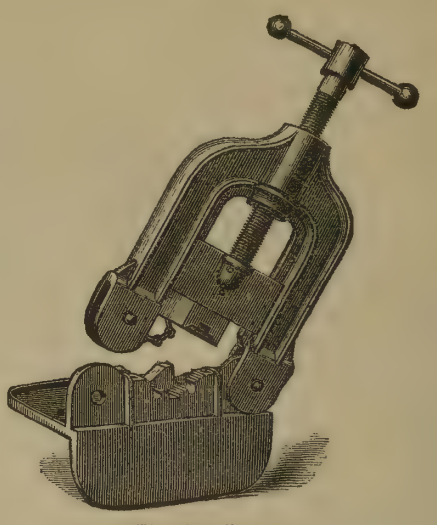


Fig. 1.—Open.

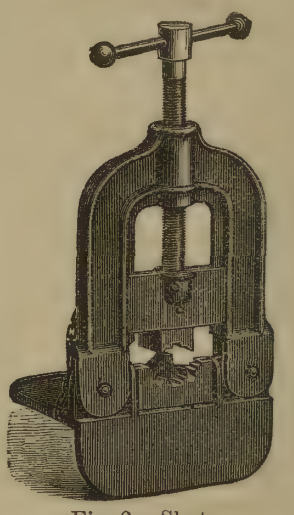


Fig. 2.—Shut.

MALLEABLE IRON PIPE VISE.

(*Made by the Eaton, Cole & Burnham Co., N. Y.*)

These illustrations represent a pipe vise, which is very light and should prove durable. It seems peculiarly adapted for work done away from the shop, being light and easily carried. The first illustration shows the manner in which it may be swung open to receive the pipe, when necessary to put it in side-ways.

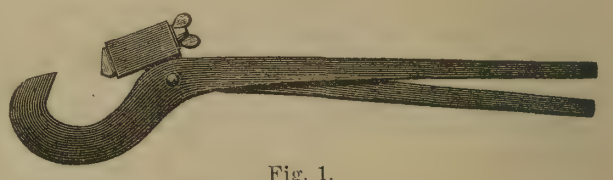


Fig. 1.

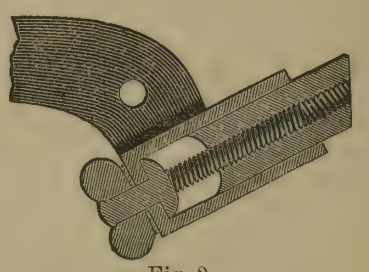


Fig. 2.

LYNCH'S ADJUSTABLE PIPE TONGS.

The cuts (which need no explanation) show a good form of pipe-tongs, made by the Eaton, Cole & Burnham Co. Fig. 2 is a sectional view, showing the working of the screw and jaw. The jaw can be ground and sharpened until used up.

ACME PIPE CUTTER.

The cut, which speaks for itself, shows the Acmé Pipe Cutter, made by Pancoast & Maule, Philadelphia; and a very powerful, serviceable and clean-cutting tool.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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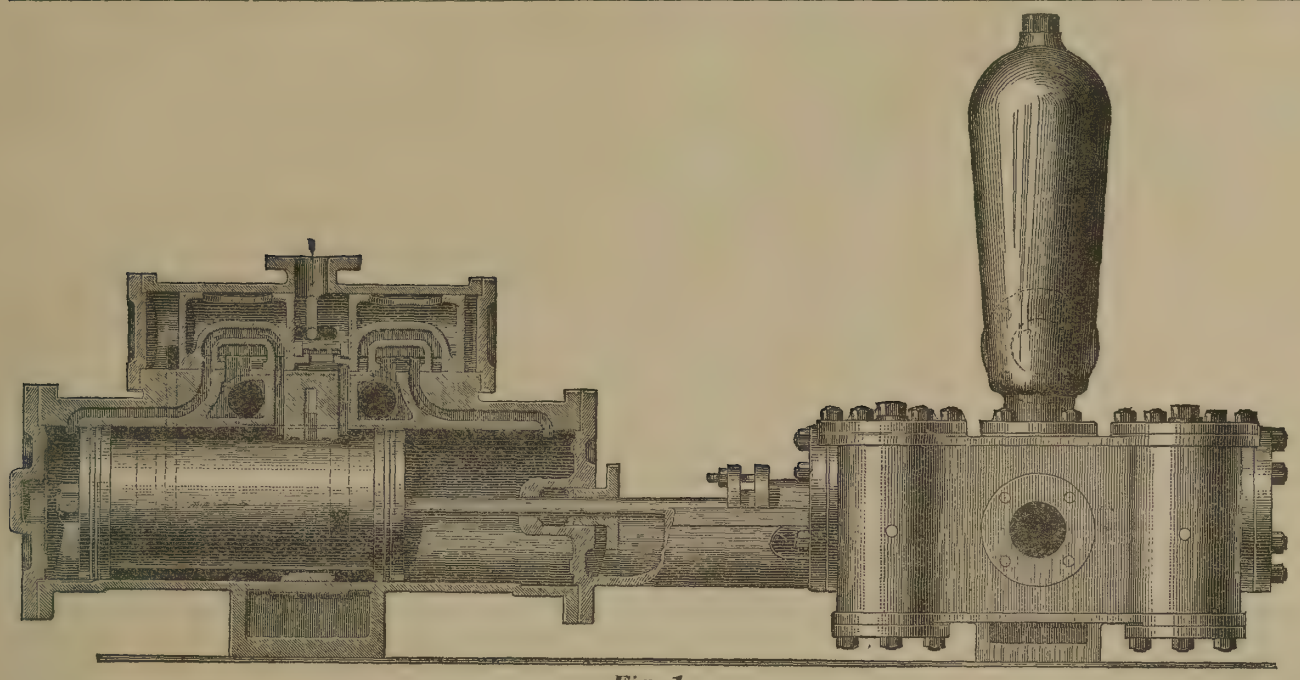

Fig. 1.

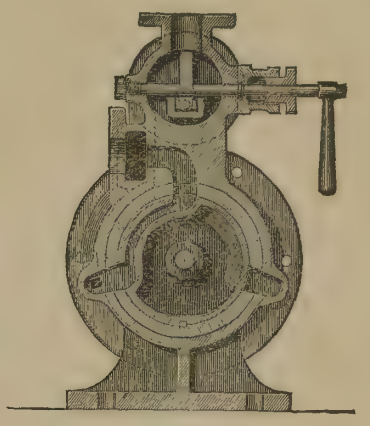

Fig. 3.

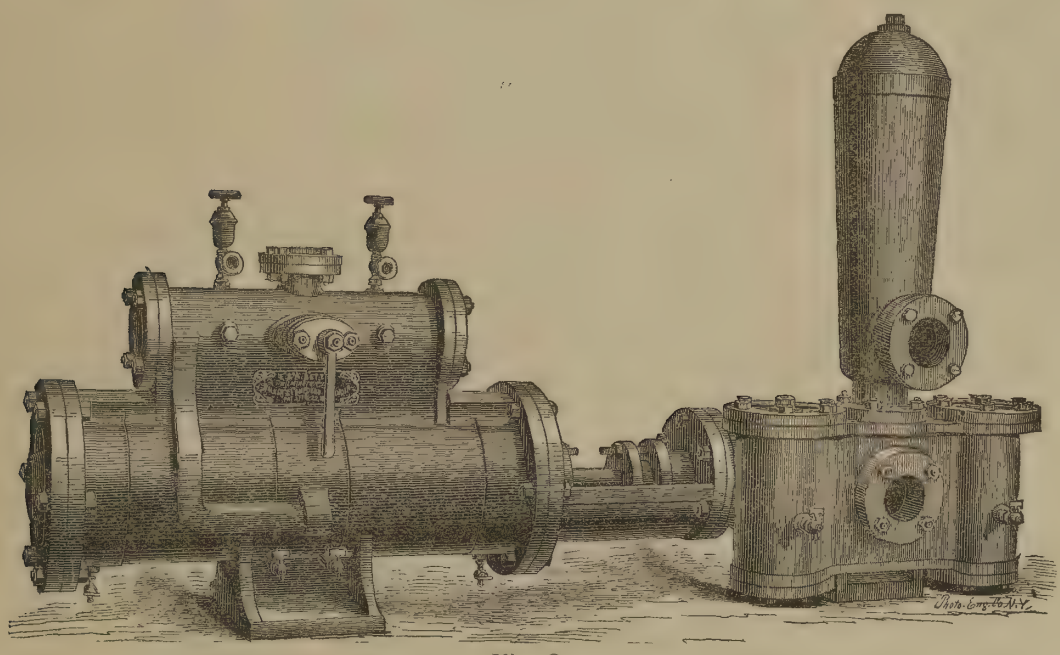

Fig. 2.

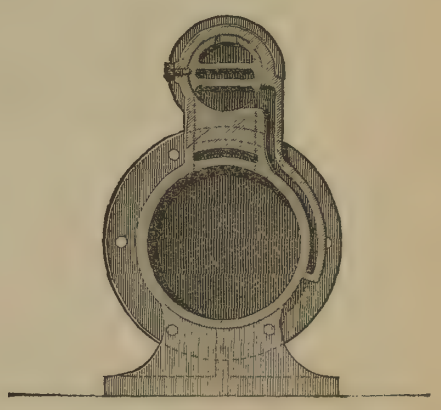

Fig. 4.

WALKER'S COMPOUND PUMP.

Direct acting pumps have come into extensive use, and they have certainly many points in their favor. They are light and compact, this being especially valuable where space and ease of transportation are objects. They have no dead centres, consequently will work slow or fast without sticking; they have even been known to work under water in flooded mines, etc. Only one (but rather important) objection has been urged against them; they use an enormous quantity of steam.

To expand the steam in a single cylinder could not well be arranged, as it would make the valve gear more complicated, and, the resistance throughout the stroke being nearly uniform, the pressure would be too high at the beginning, and too low at the end; the weight of the moving parts would (in the absence of a fly-wheel) not be sufficient to take up the surplus power at the beginning, and give it out at the end.

A compound arrangement, keeping the pressure more uniform throughout the stroke, would overcome this objection, and some attempts in this direction have been made, resulting in rather too much complication.

Mr. William Walker has avoided this fault; his new compound pump is as simple as any single cylinder pump, and much simpler than most of them; having only two moving parts on the steam side, viz., the steam piston and the valve.

As will be seen by the above cuts, the cylinder is a little longer than twice the stroke, having a piston working in each end. These two pistons are connected by a trunk, passing steam tight through a partition in the centre of the cylinder. The annular spaces thus formed take the initial steam, and, on the return stroke, expand it into the outer ends of the cylinder, whence it is exhausted into the atmosphere or into a condenser.

The distribution of steam is regulated by a double cylindrical valve, which admits the fresh steam in its centre, and has passages on each side, leading the steam from the annular spaces into the ends of the cylinder; it has also cavities for exhausting from the latter. This valve works in a cylinder, to whose outer ends steam is led from the centre by suitable passages; these end-spaces have passages leading to the above-named central partition in the cylinder, either end having its passage on opposite sides. The trunk connecting the pistons has at each end a segmental passage, one leading to the right, one to the left side (as shown in transverse sections) and, when coming to either end of its stroke, will connect one of the above-named passages with the exhaust cavity, thus relieving one end of the valve from pressure, enabling the steam on the other side to push the valve over until it has passed the small exhaust passage, thus cushioning itself against the remaining steam.

The main piston, on coming to the end of its stroke is cushioned by passing over its ports, thus compressing the remaining steam, and should this be insufficient, there is also a little groove at the bottom of the cylinder at each end, which, as soon as the piston has passed over its end, admits steam from the annular high-pressure space, thus increasing the cushion. To start the pump, there is a shaft passing through a stuffing-box into the valve chest, having a hand lever outside, and an arm inside, to move the valve.

The other parts of the pump present no special features, and as they are about the same as those of other similar machines, will need no explanation.

To arrive at a correct estimate of the economy effected by this pump, we will compare a 12-inch Walker Pump with a single cylinder pump of the same power.

We have the following data:

Initial pressure (above atmosphere).....	50 lbs.
Diameter of cylinder, 12″.....area	113 sq. in.
Diameter of trunk, 10½″.....	

Area of annular space	26.5 sq. in.
Proportion of high and low pressure cylinder	4.25
High-pressure steam port	18.55 cub. in.
Segmental port in trunk	11.25 "
Giving the two latter in inches of high-pr. Cyl.=$\frac{29.8}{26.5}$=	1.125 in.
Clearance in high-pressure cylinder	0.75 "
Whole clearance space high-pressure cylinder	1.875 "
Steam used for single stroke 26.5 sq. in (14 in. stroke+ 1.875 in.)=	420 cub. in.
Low pressure steam port and valve passage	90.4 "
Giving in inches of low-pressure cylinder	0.8 in.
Clearance in low-pressure cylinder	0.45 "
Whole clearance for low-pressure cylinder	1.25 "

To determine the expansion line, according to Mariotte, we will have to find the pressures between high and low pressure cylinders during expansion.

At the beginning of the stroke the pressure would be:

$$64.5\times\frac{15.875}{(1.25\times4.25)+15.875.}=48.33 \text{ lb. above zero.}$$

At one-fourth it would be:

$$64.5\times\frac{15.875}{(4.75\times4.25)+12.375}=31.445 \text{ lb. above zero.}$$

At one-half:

$$64.5\times\frac{15.875}{(8.25\times4.25)+8.875}=23.3 \text{ lb. above zero.}$$

At three-fourths:

$$64.5\times\frac{15.875}{(11.75\times4.25)+5.375}=18.5 \text{ lb. above zero.}$$

And at the end:

$$64.5\times\frac{15.875}{(15.25\times4.25)+1.875}=15.354 \text{ lb. above zero.}$$

We can now complete the diagram, and may allow 0.5 lb. back pressure in each cylinder.

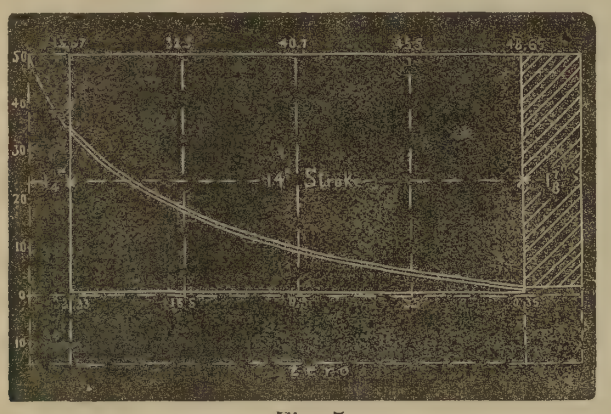

Fig. 5.

The cross-lined space on the right side shows the steam lost in the high-pressure clearance spaces; on the left side the low-pressure clearance space is added in broken lines, to show the complete expansion curve.

Computing the mean pressures by Simpson's rule, we have:

$$\frac{15.67+48.65+4\times(32.5+45.5)+(2\times40.7.)}{12}$$

= mean pressure of high-pressure cylinder	38.226
Referred to area of low-pressure cylinder = $\frac{38.226}{4.25}$	9.00

For the low-pressure cylinder we have:

$$\frac{33.33+0.35+4\times(16.5+3.5)+(2\times8.3)}{12}$$

	10.85
Total mean pressure referred to low-pressure cylinder	19.85

A single cylinder, in forming the above diagram, would give a mean pressure of 49 lbs. per sq. in., so to be equal to the 12 in. compound, must have a diameter of

$$\sqrt{\frac{19.85}{49}}\times12.^2=7.638 \text{ in.}$$

and with 14 in. stroke, will require about $46\times15.875=730$ cubic inches of steam.

In general practice a pump with a steam cylinder of 7⅞ inch diam. would have only 10 inch stroke, consequently, to pump the same amount of water as the compound of 14 inch stroke there would have to be 1.4 times the number of strokes. The loss which always takes place at the end of the stroke, would therefore be greater in the single cylinder pump.

We have now to consider the amount of steam used for the valve motion.

In Walker's Compound 12 inch Pump, the valve is 6 inches in diameter, and has about 1⅝ inch stroke, and we may suppose that the steam contained in the ends beyond the exhaust passages is retained intact. Then the steam used for a single stroke will be:

In valve cylinder 28×1.625=	45.5 cub. in.
In exhaust passage to central partition	13.5 "
Total,	59 cub. in.

The valve gear for a single 7⅞" inch cylinder would use about 40 cubic inches. The comparison would now stand:

	12 in. compound	7⅞ single cyl.
Steam used in cylinder,	420 cub. in.	730 cub. in.
Steam used in valve,	59 "	40 "
Total,	479 cub. in.	770 cub. in.

The single cylinder pump, thus shows an increase of consumption of 770 — 479 = 291 cub. in., or 60·75 per cent. over the compound.

Messrs. E. & A. Betts, of Wilmington, Del., already well known for their excellent machine tools, have taken up the manufacture of this pump, and have been careful, as regards good material and workmanship, to keep up their reputation.

J. HAUG, *Mechanical Engineer.*

THE LOWE GAS PROCESS AT MANAYUNK.

II.

To suppose that the value of the improvements detailed in our last issue will be limited to the province of illumination, would be a most short-sighted and superficial estimate of their importance. On the contrary, their direct bearing upon the metallurgical arts and domestic ceonomy will be obvious to every one who has intelligently observed and followed the manifest tendency of technical improvements relating to the methods of consuming fuel for industrial and domestic purposes. The march of invention in these provinces has been for years steadily in the direction of realizing in practice the results which have theoretically been demonstrated to be attainable by the employment of fuel in the gaseous state.

It is unnecessary in this connection to rehearse in full the numerous arguments bearing upon the enormous wastefulness incident upon the use of coal as a fuel in the industries and the household. The buyer of coal purchases *ab initio*, from 10 to 15 per cent. of non-combustible and useless material in the form of ash with every pound of coal he purchases; while through imperfections in the mechanical construction of furnaces, difficult or impossible of remedy under existing systems of construction, perhaps as much as 5 per cent. more of combustible in the form of dust or partially-consumed fragments passes through the grate bars into the ash pit unutilized.

If even now, with so much waste as just indicated, we could really obtain all the useful thermal effect of the remaining 80 to 85 per cent. of combustible, we might be content; but such is far from being the case. The gasification of the coal, which is one of the phenomena attending its combustion, is attended with the using up of large quantity of heat energy, the equivalent of the molecular work performed by the particles of carbon in passing from the solid to the gaseous state; and the heat necessary to perform this work is lost so far as useful effect is concerned, since it is stored up insensible of thermometric detection in the gaseous particles. The furnace gases, passing from the chimney at a temperature often of 800°, and carrying off with them great volumes of unconsumed carbon in the form of smoke, is another material source of loss; and the introduction into the furnace of cold air and inert nitrogen, together with conduction and radiation of heat from the generator to surrounding objects and the atmosphere, complete the category of losses. Summing up all the elements of loss, the fact that not more than 15 or 20 per cent. of the theoretical heat effect (or thermal equivalent) of coal is obtained in the most perfectly constructed furnaces or steam generators that the ingenuity of invention has been able to devise, need not excite surprise.

The great and obvious advantage attending the employment of fuel in the gaseous state, resides in the fact, to say nothing of the important advantage of convenience, that the character of the combustible permits of its instantaneous and perfect intermixture with the air, by which a vastly more perfect and intense combustion is insured, an advantage which finds admirable practical expression in the regenerative gas furnace of Siemens. Where nature, however, furnishes us with abundant supplies of combustible gases, as in certain favored localities is the case, an additional saving is obviously gained—since we are spared the necessity and saved the absorption of heat involved in the preliminary gasification required in the regenerative furnace—and the practical utilization of the product of the numerous gas wells of our oil regions will doubtless prove enormously advantageous to numerous industries in the favored regions referred to.

Where the gasification of fuel is accomplished by means of steam, as is the case in the generator of Lowe, it is scarcely necessary to explain that there is no theoretical gain in thermal energy from the simple decomposition of the elements of water, for it will be obvious that as the decomposition of the steam is effected by the agency of heat, that heat must be supplied by the incandescent coal through which it passes. The dissociation of the elements of water represents a prodigious amount of molecular work, which is exactly the equivalent of the amount of heat energy supplied by the coal, and which is used up during the operation. There is no absolute gain of potential energy involved in the process, but in reality a loss. The advantage gained is a purely *practical* one, depending entirely upon the physical or gaseous character of the resulting combustible, and this, as we have stated, is enormous.

While, as we have endeavored to show, there is no theoretical gain in utilizable heat energy in the conversion of solid or liquid fuel into the gaseous condition before combustion, we may in this place very properly enumerate a few of the incidental disadvantages on the score of convenience and economy, which are inseparable from the employment of ordinary fuel, and which, taken in connection with the various sources of loss of heating effect, before described, materially strengthen the argument in favor of the use of gaseous fuel. We refer here to certain items of saving accompanying the use of gaseous fuel, which according to circumstances are more or less prominent, but in special cases become quite important.

In this category may be classed the saving in the carriage of coal from the yard to the place of delivery, and the recarriage of ashes; charges which are especially onerous in the numerous cases where boilers, stoves, etc., are located in upper stories of buildings, or located inconveniently as regards ordinary delivery by wagons. The saving in wages of stokers to clear the fire-places and keep the heat of the furnace, etc., at the proper degree of intensity, difficulties which the employment of gaseous fuel would entirely obviate, since in the first place there are no ashes to clog the grate or to remove, and the proper regulation of the gas supply, would insure a perfectly uniform heating effect for hours together without supervision or attention of any kind,

The incidental saving of fuel or steam, whenever, by improper regulation or inattention of stokers, which frequently occurs, the furnaces are allowed to become too

hot; and, on the other hand, the saving involved in the time lost (and materials spoiled) by low fires and the frequency of stoppages, until the required steam pressure is restored; and last, but not least, the large saving of fuel now universally wasted in keeping up boiler and range, heater and stove fires over night. All these, and other items which have possibly been overlooked, form together an array of objectionable features which we believe will only find their proper remedy in the abandonment of the present system of generating heat. They are, it is true, to a certain extent obviated by the use of pulverized fuel, several systems of which have been lately practised with notable success; but such mechanical artifices, though they will doubtless possess a permanent value in affording a practical method of utilizing fuel that would otherwise be a waste product, are but half-way measures, and their very success but an additional argument in substantiation of the claims of gaseous fuel upon public attention.

The fuel of the future we believe will be of gaseous nature; fuel for our mills, factories, workshops, parlors and kitchens will be "laid on" as lighting gas and water are at present supplied, and we regard the system of Mr. Lowe, by which enormous volumes of combustible gases (carbonic oxide and hydrogen) may be rapidly, cheaply, and continuously produced by the mutual interaction of superheated steam and incandescent carbon, as a notable forward step toward the practical realization of this "consummation devoutly to be wished." W.

TO MANUFACTURERS.—We have inquiries from Germany for the addresses of manufacturers of Street Car Locomotives, Tack Machines, and Shoe Peg machinery; from Brazil, for Brick Machines and Saw-Mill makers; and from Sweden, for Wire Rope Twisting Machines and Stove Patterns.

NITRO-GLYCERINE.

III.

Owing to numerous accidents that had occurred with his nitro-glycerine, Nobel, its first manufacturer, for blasting purposes, was led to produce a preparation of nitro-glycerine which has become quite popular. This preparation is called dynamite, and is the type of a large number of nitro-glycerine powders, with a single exception, which will be noticed further on. Nobel's dynamite consists of a very light, mealy infusorial earth (which occurs very pure in an extensive deposit at Hanover), which is permitted to absorb a quantity of the nitro-glycerine. An accident led to its production. The siliceous earth had been used in the packing of the metallic cans of the explosive; by the breaking of one of these, the observations were made that the earth was possessed of great absorptive power; that when thus absorbed the explosive qualities of the nitro-glycerine were not destroyed, and that its tendency to explode spontaneously was materially reduced.* To prepare the dynamite, the infusorial earth is first calcined in order to remove the water and organic substances it contains, and after the coarser particles are removed by sieving, the nitro-glycerine is added, and the mixture thoroughly kneaded by the workmen with bare hands. Nobel's dynamite contains, according to Bolley,† from 75° to 77° nitro-glycerine, and from 23 to 25 p. c. of infusorial earth. Like nitro-glycerine, dynamite will simply burn when ignited with a flame, and requires the use of a fulminate in order to be exploded. It is affirmed to be indifferent to blows and shocks, and numerous experiments are cited to prove that it may be thrown in considerable quantities from considerable heights, and that heavy weights may be thrown upon it without effecting its explosion. Of late a large number of explosive mixtures of nitro-glycerine with inactive and active substances have been introduced, few of which, however, possess any special interest or merit. A mixture of sponge or vegetable fibre with nitro-glycerine is known as *porifera* nitroleum; mixed with red lead, nitro-glycerine becomes metalline nitroleum; with plaster-of-paris, selenitic powder; with sawdust, dualin; mixed with certain active substances, such as gunpowder, nitrates, etc., it is variously known as colonial powder, giant powder, rend rock, lithofracteur, etc.

Without attempting a settlement of the rival merits of these mixtures, it is obvious that, so far as effectiveness is concerned, they must all be notably inferior to pure nitro-glycerine. Where an indifferent absorbent like chalk, plaster, or infusorial earth is employed, the explosive energy, or disruptive force of a discharge, will be diminished in more than a direct proportion to the amount of the adulteration, for it has been urged that the explosion of the nitro-glycerine upon the surfaces and in the interstices of such powders is not absolutely simultaneous. The effect of the explosion is therefore, if this view is correct, materially weakened; the effect is that of several weak blows, the disruptive energy of which will be far less than that of one powerful blow. The addition of such substances as gunpowder, nitrates, chlorates, and the like, if made with the notion that they increase the effectiveness of the nitro-glycerine, is radically false. The explosion or combustion of all such substances is so enormously less rapid than that of nitro-glycerine, that far from contributing to the effectiveness of a discharge, they constitute so much inert adulteration, the only effect of which becomes apparent in the gases which they subsequently generate to the detriment of the workmen.

Where non-absorbent substances are used to carry the explosive it is possible that its disruptive energy will not be diminished, certainly not to the degree that it is, with the absorbent powders before described. The only mixture of this nature that has yet come to our knowledge is the so-called mica blasting powder of Mr. Mowbray. This material consists of tri-nitro-glycerine mixed with the exceedingly finely divided scales or laminæ of mica. In this mixture there is no absorption, the explosive simply adhering to the surfaces of the laminæ.

President H. Morton, of Stevens Institute, Hoboken, reports the following interesting experiments confirming the above opinions: I have made a number of experiments with such mixtures as you mention, and will relate them.

I first took 15 grammes each of dynamite sent me by complainants, and stated by them to contain 77 per cent. of nitro-glycerine and of Mowbray's mica powder, which I had mixed myself and knew to contain 52 per cent. of tri-nitro-glycerine.

These being exploded in two precisely similar barrels, the mica powder produced double the effect of the dynamite. As this seemed to indicate that the infusorial earth had an injurious effect on the explosive action, I tried a cartridge made up with Mowbray's tri-nitro-glycerine, *i. e.* 52 nitro-glycerine to 48 infusorial earth.

This mixture, however, entirely refused to explode, not only with the fuses used in all the other experiments, containing about 16 grains fulminate, but even when an exploder containing 22 grains fulminate was inserted in it, and the whole introduced into an iron tube and tamped with sand; in this case the iron tube was split open by the explosion of the fuse, but the mixture of infusorial earth and nitro-glycerine remained unaffected. This experiment seems to me to demonstrate that in this proportion infusorial earth is able entirely to destroy the explosive character of nitro-glycerine.

On the other hand, when nitro-glycerine is mixed with mica scales in the same proportion, the effect was the same as when the same quantity of pure nitro-glycerine was used alone. It therefore appears to me that *this material (mica scales) has no effect whatever* in retarding or diminishing the *explosive action of nitro-glycerine.*

The prodigious explosive energy of nitro-glycerine will be comprehended by an inspection of the accompanying tabulated figures, which give the comparative qualities of a number of the explosives. To enter into a detail of the results of practice would consume far more space than we have at disposition. The figures in question are given on the authority of Mr. Berthelot.

	Heat.	*Volume of gas.*	*Estimated Explosive Force.*
Blasting powder	509	0.173 litres	88
Artillery do	608	0.225 "	137
Sporting do	641	0.216 "	139
Powder, nitrate of soda for its base	764	0.248 "	190
Powder, chlorate of potassa for its base	972	0.318 "	309
Gun cotton	590	0.801 "	472
Picric acid	687	0.780 "	536
Picrate of potash	578	0.585 "	337
Gun cotton mixed with chlorate of potash	1420	0.484 "	680
Picric acid do	1424	0.408 "	582
Picrate do	1422	0.337 "	478
Nitro-glycerine	1320	0.710 "	930

The first column indicates the heat furnished by one kilogramme of the explosive; the second column, the volume of gases disengaged; the third, the resulting product of these two quantities, serving as an approximate estimate of its explosive power. Commenting upon the above figures, M. Papillon remarks that nitro-glycerine is "really the ideal of portable force. It burns completely, without residue, in fact gives an excess of oxygen; it develops twice as much heat as powder, three and a half times more gas, and has seven times the explosive force, weight for weight; and taken volume for volume, it possesses twelve times more energy." M. Berthelot says further, "Theoretically there is but one substance that can surpass it, *i. e.* liquefied protoxide of azote, mixed with ether or other liquefied carburets; these mixtures range up to 1400° of heat, and their energy is expressed by the number 1000. But it is commercially impossible to obtain the instantaneous explosion of such mixtures formed with liquefied gases, because it would be necessary to compress these gases into a liquid form, preserve them in vessels hermetically sealed, in which form they must be mixed and fired."

The foregoing results however, as has been intimated, are only approximately correct, as one highly important element—namely, the comparative times in which an explosive is converted into gaseous matter—or, to put it differently, the comparative instantaneity of the explosion has been left entirely out of consideration. This element, as Mr. Mowbray very tersely says, "is the very essence of disruptive force;" and if introduced as a factor in the problem, would doubtless raise the comparative efficiency of nitro-glycerine to ten times that of gunpowder. At some future time we hope to present some details of the methods of employing nitro-glycerine in practice.

Nitro-glycerine cannot be exploded by simple ignition, but must be set off by means of a powerful fulminate, which last is exploded by the electrical spark. The manufacture of these compounds and of the methods of certainty and properly exploding the charges, have of late been greatly improved. To enter, however, into their details would cover too much space in a single article.

W.

HOW TO SETTLE A DISPUTE.—The Centennial Judges and Commissioners catch severe scoldings from exhibitors who have received no awards, and from those who do not monopolize all of the praise bestowed upon classes of articles. The former think the medals and certificates of no value, on the "sour grapes" principle; the latter regard them as too cheap and commonly distributed to be worth much. There is only one way to test the soundness of these depreciatory opinions. The Commissioners do not publish the language of the decisions. Perhaps, in justice to the contributors, they ought to do this and acquaint the whole world with the official result of the competition. As this is not done by the Commissioners at the expense of the Fair, the winners of the prizes have no option but to do it for themselves. Let the unprejudiced public be the arbiter in these disputes about the practical worth of the awards. The test is easily made. A reasonable amount of advertising in the papers would tell everybody what the judges said of any particular article and where it can be found. People could then hunt it up and see for themselves whether it tallies with the judges' descriptions or not; and at the same time the successful exhibitor would learn from this *experimentum crucis* exactly what the award is worth to him. There is no other possible settlement of the controversy but by advertising. We still adhere to the opinion that the prize system adopted by the fair managers is the best under all the circumstances, and the recipients of the certificates have it in their power, by judiciously advertising, to turn them into money. [*Journal of Commerce.*]

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* Dingler's Polyt. Jour., ccv, 429. † Handbuch d. Chem. Tech., vi, 67.

THE COLBURN POROUS EVAPORATOR.

The fact that the dry air supplied to rooms in winter, by hot air furnaces, stoves, &c., is unwholesome, and is the primary cause of much physical distress, has long been known, and many contrivances have been devised to do away with this objectionable feature in question. In this connection, we present herewith an illustration and description of a very simple and efficacious evaporator for supplying moisture to artificially-heated apartments, which has been for some time under our notice. The following is an abridgement of a report lately made by a committee of the Wagner Free Institute of Science, which was appointed to examine the "Colburn Porous Evaporator."

"The ordinary system of heating buildings by hot air, steam, or hot water, passes air over heated, and in many cases *highly* heated, surfaces and increases the capacity of that air for moisture. Unless water be added to it, the heated air at once proceeds to supply its deficiency by absorption from the wood work of the house (causing joints to gape), the furniture (causing it to crack), or the leaves of plants, and the skins, and delicate mucous membranes of occupants of the house. These latter being extended evaporating surfaces, with constant internal supply, are dessicated by preference, and the wood work and furniture are partially protected at the expense of human health and comfort. The addition of a metal water pan in the air-chamber of a hot air furnace is only a partial remedy, for there is not an "extended evaporating surface," and what water is hurriedly absorbed by the air is partially re-absorbed by the flues. In "Colburn's Porous Evaporator," such a porous surface is provided. There is a cylindrical vessel, of porous earthenware, slightly tapering towards the bottom and with a slight flange projecting inwards over the mouth.

Where there is a hot air register in the floor, the evaporator is suspended in the mouth of the hot air pipe, directly under the fans of the register, so that in each case the entire quantity of water is evaporated into the room, thus obviating the pernicious effects of the dry heated air, which has rendered furnaces, stoves, &c., so objectionable heretofore.

Where the register is in the wall, the evaporator is enclosed in an ornamental perforated metalic case, B, which is attached to the face of the register A.

The latter adaptation is also available where hot water or steam-pipes, or stoves are the sources of heat.

Last winter the Colburn Evaporator was carefully tested on a steam-pipe at the office of the REVIEW, and on a register at the home of one of the editors, and, from personal knowledge, we may bear witness to its simplicity and excellence.

CONCERNING SPONTANEOUS COMBUSTION.

VIII.

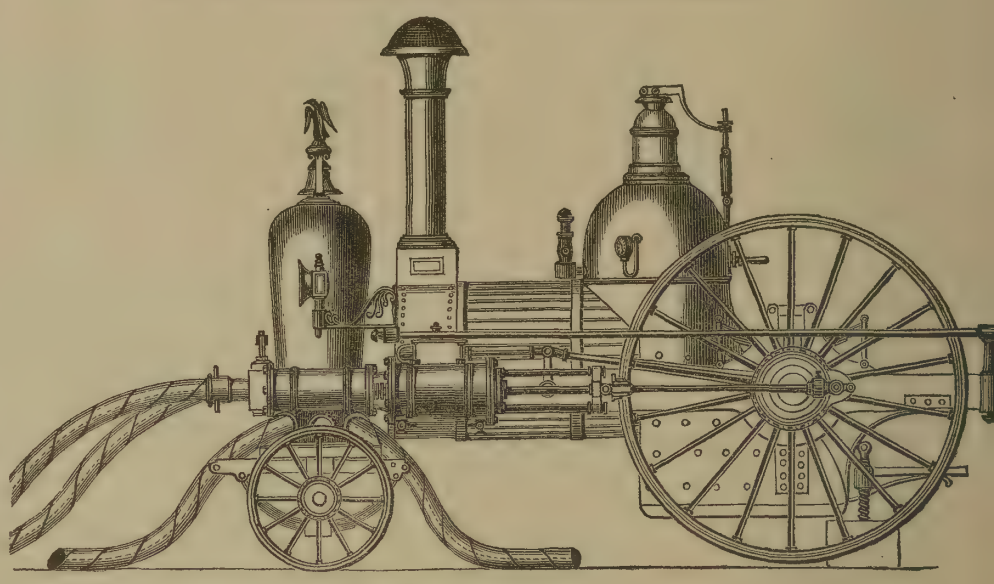
It is proper at this point to refer to the ignition of flour dust, which occasionally transpires in the most unexpected manner in flouring mills. The explanation of these accidents is quite simple, although their sudden and unexpected occurrence has earned for them a place in the popular catalogue of mysteries. The name of spontaneous combustion, which is often applied to them, we may positively affirm, is quite incorrectly applied. Such occurrences are simply and solely explosions, and the ignition of the explosive mixture(flour dust, and air) is brought about by the production of a spark, either from the heating of the stones in consequence of an obstruction to the feed, or from the accidental introduction between the stones of some gritty substance. The process is precisely analogous to the ignition of such explosive mixtures as naphtha or gasoline vapor and air, which require the application of a fire heat, either from a flame or spark, to some portion of their mass, before they will explode; and the term spontaneous combustion is no more applicable to the flour-mill explosions than to these.*

The preceding considerations, we trust, will have made it apparent that the phenomenon of spontaneous combustion is neither accidental nor mysterious as to the method of its occurrence; but that, on the contrary, with given substances under known conditions, it may be predicted with something quite akin to certainty. The method of its origin, in almost every case so uniform as to be practically identical, indicates at once the certain and very simple means by which it is to be guarded against and prevented. With classes one and three, the preventive measures must needs be peculiar for each specific case. Such cases, however, are of rare occurrence. With the second class, which comprises all the phenomena of slow combustion, the precautions to be observed to prevent them are very much the same in every instance. In the case of oily waste, its accumulation in quantity should be strictly avoided wherever this is possible; it should be kept as perfectly dry as possible; and more than all, where its accumulation cannot be avoided, constant or regulated ventilation should be maintained throughout the mass by frequent turning or otherwise. A method of indirectly effecting the diminution of accidents from the ignition of such substances, resides in the substitution of the paraffine or other related hydro-carbon oils for lubricating and other purposes in factories and workshops. Wherever this is feasible, and we can see no difficulty for the vast majority of situations, the substitution of the mineral for the vegetable or animal oils, cannot be too strongly recommended on the score of safety, inasmuch as the former are not absorbents of oxygen, and therefore have no tendency to oxidize and heat spontaneously. Where the foregoing suggestions are intelligently carried into practice, the liability to such accidents as we have dealt with will be practically nullified; at least they will be reduced to a minimum. No greater folly could be perpetrated by the manufacturer, manager, machinist or workman, than to ignore the facts here advanced, for their very silent and insidious nature, which may perhaps prompt such consideration of them, is that which constitutes the chief element of danger.

We can conclude our discussion of this interesting theme most fittingly in the words of an excellent writer on the subject,* who remarks most appropriately; "With the proper conditions it (spontaneous ignition) is as certain as the firing of gunpowder with a spark. The cask of gunpowder, so instinctively dreaded, will not explode until the spark is applied. The pile of oily waste, harmless and innocent to all appearance, slowly but surely takes from the oxygen of the air the means for its own combustion, itself lighting the conflagration, which most frequently bursts forth when the manager and operatives are locked in slumber." W.

* Vide, Proceedings of the Philos. Society of Glasgow, 1872-73, p. 280. Macadam, on Flour Mill Explosions.

FIG. 33—THE FIRST STEAM FIRE ENGINE IN AMERICA.



MODERN FIRE ENGINES.

IX.

THEIR EARLY RECORD IN AMERICA.—The first steam fire engine made in the United States was built by Paul Rapsey Hodge, C. E. (an eminent Englishe ngineer), in New York, in 1840–41. It is shown in Fig. 33.† It was self-propelled; had two horizontal cylinders and pumps, a locomotive boiler (Bury style), with flaring fire-box; and wrought iron wheels. Stephen Thurston was Mr. Hodge's foreman. The work was commenced Dec. 12, and completed April 25. The main running wheels were used in action as fly-wheels; the main axle was divided with a sleeve socket joint; but when blocked up and in working order, a clutch-pin connected the axle and brought the two crank-pins on the wheel-faces, at right angles to each other; the connecting rods were then attached. The cylinders were 9½ by 14 inches; the pumps 8¼ by 14 inches; the piston rods working through the engine and pump direct.

There was an air-vessel to each pump, but both on one bed-plate and acting together. The discharge water-ways were straight. This engine lifted water 12 feet through 4 lengths of suction, and threw 166 feet high with 2⅛ in. nozzle; throwing 10,824 lbs. (after allowing 1-6 for loss), with 120 revolutions per minute.

In 1851, W. L. Lay designed at Philadelphia a self-propelled steamer with rotary pump, and a plan to operate the engine by carbonic acid gas while raising steam.

In 1853, A. B. Latta, of Cincinnati, built a three-wheeled "self-propeller." There were two horizontal cylinders (one on each side of the boiler), the pumps being in front of the cylinders and driven direct. The engines were made to couple, when required, with the driving wheels—which were behind the fire-box.

G.

(*To be continued.*)

"PHONOGRAPHY combines the legibility of long hand, with more than the brevity of ordinary short-hand. The system is capable of answering every requirement of the man of science or business, as well as of the professional reporter; yet it is so simple, that its principles may be mastered in a few hours, and an hour's daily practice for a month, in reading and writing, will enable the student to use it with safety and some degree of freedom; while the same amount of practice, continued for six or eight months, will enable any one who has acquired facility in using the pen in common writing, to report speeches, sermons, lectures, etc., delivered at the rate of a hundred words per minute. By continued practice, the writer will be able to report a rapid speaker verbatim."

BRAZIL is a good market for turbines and saw mills.

* Mr. John L. Hayes, (*loc. cit.*)

† Given by courtesy of Mr. S. Roper.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The *Rio Grande*, the twenty-third iron steamship built for commercial purposes by John Roach, within the past four years, was launched from the yards at Chester last Saturday. The new vessel is 310 feet long, 39 feet wide, and 21 feet deep. She is capable of carrying 5000 bales of cotton, besides having a large passenger capacity. [*Am. Manuf. Oct.* 26, 6].

Allegheny Valley R.R. The *Oil City Derrick* says: The Allegheny Valley Railroad bridge shops, on the South Side, are driven with business at present. Fifty hands are employed in the manufactory, besides gangs for putting up the completed structures. Bridge timbers are shaped, finished, and painted, and then packed upon flat cars, whence they are transported to their destination. Everything is so arranged that the pieces can be fitted together in an incredibly short time. Sunday is the day always employed for the work of raising a wooden bridge on account of the few trains that are run at that time, and generally twenty-four hours are sufficient to complete the work, or at least advance it to such a stage as to permit of the passage of trains. The large extent of territory covered by the Allegheny Valley road and its branches necessitates a constant renewal and repairing of bridges, hence the extensive shops of the company are kept very busy in supplying the demand.

Italian Railways. The Coma [?] and Chiasso Railway was inaugurated September 28th. This line possesses a somewhat special importance, as it unites the Milan and Coma line of the Lombardian system to the St. Gothard line. The Chiasso station thus becomes an international terminus.

At the close of 1875 Italy had 4.716⅞ miles of railway in operation. These lines had involved a total outlay of £82,822,120. The outlay made for rolling stock on the same, £9,010,720. The largest proportionate amount of rolling stock appears to have been placed upon the upper Italian lines. This group of lines also involved the greatest proportionate cost in its construction. Including rolling stock, the average cost of the Italian railways to the close of last year will be seen to have been about £19,000 per mile. [*R. W. World*, ii, 699].

Japanese Railways. Japan indicates her progress in the march of civilization by adding a new railroad 30 miles in length, just opened between Osaba and Kiota, making some seventy-five miles now in operation. With her area of 150,000 square miles, and her population of over 33,000,000, she will undoubtedly, in a few years, have a great system of railroads, and show a corresponding advancement, increase, and prosperity. [*R. W. World*, ii, 699].

A Gigantic Order for Steel Rails. "Iron" says: *L'Echo des Mines*, which was the first to publish the order for 180,000 tons of steel rails, by the Paris, Lyons and Mediterranean Railway, now inform us that this order has been raised to 215,000 tons; the greater part of this increase is due to a supplementary order for 30,000 tons, which M. Virdie, of Firminy, had influence enough with the board to have granted him. The whole order will form a sort of "stock job" for about five years, for the Chatillon, Commentry, Terrenoire, Creusot, Denain, and Firminy establishments, and will furnish sufficient material for a renewal of a third of the whole length of the permanent way of the company, releasing an enormous quantity of old material. If general business improves, the price of steel is certain to rise; and if it goes up to its normal rate of £11 4s., the Paris and Lyons company will have netted £360,000 on its order, which it gave out at the rate of £9 16s. Its total value is £2,066,800. The Chatillon, Commentry, Commentry-Fourchambault, the Marine Steel Works, the St. Etienne Steel Works, and the Firminy Steel Works, were not long since joined in a syndicate for opposing the competition of certain steel works, and for the mutual division of large orders. This syndicate was dissolved just before the large order we have spoken of was given out. [*R. W. World*, ii, 701].

Stone Ballasting. The work of stone-ballasting the Pennsylvania Railroad between Jersey City and Philadelphia has progressed so rapidly that the contractors expect to complete the undertaking by the middle of next year. Operations were begun in August, and the workmen have thoroughly ballasted the main tracks from East Newark to that point, a distance of seven miles. Operations are to be continued between Newark and Elizabeth, which gap of five miles will be completed before snow flies. The stone used in this undertaking is excavated from the new cut near Marion. Before being placed on the road the particles of rock are thoroughly screened and freed from dust, which will relieve the track from flying clouds of sand and gravel in the summer, and will also tend to render the road-bed compact and solid. The total cost of the improvement will be $225,000. [*R. W. World*, ii, 701].

—The general estimate, based on experience, is that circular saws work most satisfactorily when running 150 feet per second, or 9,000 feet per minute, or 100 miles an hour. Thus when a saw is one foot in diameter, or three feet in circumference, every revolution is equal to three feet, and this divided into 150, gives 50 revolutions per second, or 60x50=3,000 per minute; 6-inch saws, twice as fast; 2-foot saws, half as fast, and so on. [*Lumberman's Gazette*, viii, 294.]

Master Mechanics' Association Circular of Inquiry.—The Committee appointed by the American Railway Master Mechanics' Association to report on the "Purification of Feed Water and Formation of Boiler Incrustations," presents the following questions:

Effect of Incrustations on the Consumption of Fuel.

1st. How many miles per ton of coal do engines with clean boilers average on your road?

2d. How many miles per ton with boilers from which incrustations have not been removed?

3rd What do you estimate the loss to be in money, per year, for fuel used on account of formation of scales in boilers on your road?

Effect on Life of Furnace Sheets and Outside Shell, and of Flues.

1st. To what extent, in your opinion, is the life of a copper, iron, or steel furnace shortened by the formation of scale in boilers on your road?

2d. To what extent is the life of flues shortened by the same cause?

3d. In what manner do incrustations effect the sheets in out side shell of boiler, and to what extent is the service of such sheets lessened by the action of incrustation?

Remedies and Cost.

1st. What is the cost per engine, per year, on your road, for removing the incrustations from locomotive boilers?

2d. What so-called "anti-incrustators" and boiler compounds have you tried for removal or prevention of boiler incrustations?

3d. Have any proved successful; and if so, what are they?

4th. What does it cost per engine, per year, to use those which prove beneficial?

5th. Have you tried any plan for purifying feed water for locomotive boilers, and if so, please describe it, and state the cost of the process per 1,000 gallons of water purified?

Please reply before March 1, 1877, addressing the Chairman of the committee, E. T. Jeffery, Assistant Superintendent of Machinery, Illinois Central Railroad, Chicago, Ill.

E. T. Jeffery, Illinois Central R. R.; H. L. Cooper, I., B. & W. R. R.; J. C Willis, T. W. & W. R. R., Committee.

MINING, METALLURGY AND MINERALOGY.

Wyoming Coal and Oil Discoveries.—A new coal mine has quite recently been opened near Hillard, Wyoming, from which the village will be supplied this winter, at $4 per ton, delivered. The oil well, about two miles west, is being worked, and yields a barrel a day. It is sold to the railroad for forty cents a gallon, by whom it is used for lubricating purposes. The well is now fifty feet deep, and the owners are sinking it still deeper, with the prospects of securing a much larger yield. [*Eng. and Min. Jour.* xxii, 278].

The Southern California Oil Fields.—It seems no longer open to doubt that we have an oil-bearing belt over a wide stretch of territory running through Ventura County. Several wells have already been sunk in the vicinity of Andrews' Station in the San Fernando district, and are supplying from 10 to 20 barrels per day each. All these wells are yet but of shallow depth, and the quantity and quality of the oil may be expected to improve on the lower levels. But even these wells will produce from seventy to seventy-five per cent. of refined oil. In Santa Paula district, adjoining the Sespe district, Adams & Thayer, who own 47,000 acres of land have put down several wells, and only last week struck a flow of fourteen barrels per day at a depth of 104 feet. They also have a refinery, and the oil made is of an excellent quality and burns as well as that of Pennsylvania. On the favorable report of our correspondent, the California Crystal Oil Company has been incorporated with a capital of $1,000,000. [*Journal of Commerce*, Oct. 18.]

Novel Mode of Strengthening Cast Iron.—The president, Mr. R. M. Bancroft, and members of the civil and mechanical engineers' society, when visiting Kirkaldy's testing and experimental works the other day, were shown a cast iron bar which had been sent to him to test as a sample that had been treated with mysterious chemical mixtures, which were said to increase its tensile strength over fifty per cent. But as Mr. Kirkaldy's rule is always to break the specimen, or else his machine, he found it contain, upon being fractured, a center core of wrought iron about two inches in diameter, and six smaller ones of the same metal spaced around it. He thus exposed the secret. [*Min. and Sci. Press*, xxxiii, 267.]

Gold Mining in French Guiana.—Consul Wooldrige, reporting to the Foreign Office on the trade of French Guiana, notices the general abandonment of agricultural labor in the colony in favor of the gold industry, The value of the gold finds in the year 1875 rose to £64,300 more than in 1874. Of the £252,925, the value of the total exports of 1875, the exports of native gold supplied no less than £227,568, stated as the value of the 113,118 ounces exported. [*London Times.*]

Southern California. It is every day becoming more and more apparent that the southern part of the state is bound to become one of its most important sections, and second to none in it. The completion of the Southern Pacific railroad to Los Angelos, and its prospective continuation to the Colorado and the Rio del Norte have given rise to more than ordinary interest in connection with it and its products. That it contains great but undeveloped deposits of gold and silver, we have long believed, and that not many years will have passed over ere our faith in the auriferous and argentiferous resources of this section will have been justified. Its oil resources are only now becoming properly known and appreciated. The oil region, so far as it has been explored, extends fifty miles, and can produce at least 10,000 barrels of refined oil per day; indeed some well known oil men think that it may possibly go up as high as 20,000 barrels per day, or 6,000,000 barrels for 300 working days per year, worth in the present condition of the market $27,000,000 per annum, or as much as our wheat crop has been estimated at this year. It is the home of the grape, the orange, and the olive, and will be the banner wine region of California. It will produce honey for all America. Los Angeles, the city of the angels, or rather of the queen of angels, which might well be called the Garden City, has already a population of 12,000, and is increasing yearly in geometrical ratio. [*Journal of Commerce*].

CHEMISTRY, PHYSICS AND TECHNOLOGY.

A Curious Phenomenon has been described to the Belgian Academy by M. Spring. A sheet of thin vulcanized rubber, stretched to about six times its normal size, is rubbed with a cloth until it will attract light bodies. If, now, it be allowed to contract, the electrical attraction will diminish as the sheet becomes smaller, until it entirely disappears when the rubber has resumed its ordinary size. That the electric state is dependent to a certain extent on the molecular arrangement of the rubber (or sulphur) would appear to be evident; but the phenomenon deserves the attention of physicists. [*Eng. Mech.* xxiv, 142.]

Improvement in Chemical Balances.—In the use of a sensitive laboratory balance there is often a considerable loss of time, due to the number of oscillations the balance makes before coming to its position of equilibrium. M. Arzberger has sought to remedy this as follows:—At the upper part of the stirrup supporting each scale he suspends, by means of a metallic rod, a thin disk of brass, 67mm. diameter, fixed by its centre so as to be in a horizontal plane. This plate is introduced into a vertical cylinder of brass, supported by the fixed part of the apparatus, having a diameter of 68mm., and so permitting the disk to move vertically in the interior without friction, an annular space of about half a millimetre, separating the border of the disk from the surface of the cylinder. The cylinder being closed at the lower part, the disk, when it descends by the movement of the balance, tends to compress the air in the cylinder, which can only escape by the annular space; thus a certain resistance is experienced. On the other hand, when the disk rises, the interior air is dilated, and again acts so as to retard the motion. In this way the oscillations of the balance are materially diminished without affecting the conditions of equilibrium. [*Eng. Mech.*, xxiv, 143.]

Aurantia.—The Berlin *Gesellschaft für Anilin Fabrication* has lately brought in the market a substance having the above name, which is distinguished by the property of coloring silk and woolen a magnificent orange. The substance appears, however, to exert an unpleasant irritation upon the skin of the workmen, which in certain cases is declared to be dangerous. The makers, on the other hand, claim that value of the new color is so great as to make this unpleasant feature quite subordinate, and they instance, furthermore, a number of coloring substances in general use among dyers that produce even more disagreeable effects upon the workmen. [*D. Industrie Ztg.* No. 41, 406.]

An Improved Breech-Loader, the invention of M. Kessler, and based on the Peabody system, is described in the second September number of *Dingler's Polytechnisches Journal.* There are several other interesting papers in this number—on the manufactore of jute, new blasting agents, telegraphic apparatus of Siemens and Halske, of Berlin, the most recent standpoint of the rice-starch manufacture, &c.

Jointless Pails.—E. Murdock & Co., of Winchendon, Mass., have recently perfected an ingenious machine for the manufacture of toy pails. This machine is so constructed that the bodies or barrels of five pails of different sizes are turned out from one block, and finished ready to receive the bottoms, at one operation. There are no joints, therefore hoops are not required to hold them together. [*Lumberman's Gazette*, viii, 310.]

To Join Band Saws:—Bevel each end of the saw the length of two teeth, be sure and make a good joint. Fasten the saw in the vise, with the back against the shoulder; wet the gas with muriatic acid, or cover them with fine borax; put solder the size of the lap between the joints, and clamp the joint with the tongs heated to a light red; as soon as the solder fuses, cool the tongs slightly with the water. Remove the saw, hammer it slightly, if necessary, file to an even thickness, finish lengthwise, and the saw is ready for use. [*Lumberman's Gazette*, viii, 310.]

The Profitableness of Irrigation.—During recent years the British Government has invested something like seventy millions of dollars in irrigation works in India, and it is proposed to spend thirty millions more for such purposes during the next five years. In almost every instance the works have proved immediately remunerative, while in some cases the profit has been enormous.

For all India the net annual revenue from irrigation works now amounts to upwards of five million dollars, or 7·7 per cent. of the capital invested.

Artificial Fuel.—In the manufacture of artificial fuel, Mr. F. J. Hamel, of Avenue road, Regent's Park, proposes in the first place to take china-clay, and after bringing it to a dry state, reduce it to a powder, and either introduce it into coal dust or other substances before or after he has prepared a solution of mineral or vegetable pitch, combined with resinous and fatty and oily matters, the whole being then agglomerated together; they are further mixed by a pug mill or travelling screw, and as they travel or are in motion he applies jets of superheated steam to assist in the full amalgamation of all the ingredients. He next places the prepared materials in presses for solidification. [*Builder's Reporter, London.*]

Tempered Glass.—Mrs. Nassau Senior writes to the *Times* on the curious behaviour of tempered glass. She furnished twelve gas burners with tempered glass globes purchased in London, and having the veritable label of M. de la Bastie affixed to each. On the night of the 6th inst. after the gas had been extinguished for exactly an hour, one of the globes burst with a report and fell in pieces on the floor, leaving the bottom ring still on the burner. These pieces, which were, of course, perfectly cold, were some two or three inches long, and an inch or so wide. They continued for an hour or more spliting up and sub-dividing themselves into smaller and still smaller fragments, each split being accompanied by a slight report, until at length there was not a fragment larger than a hazel nut, and the greater part of the glass was in pieces of about the size of a pea, and of a crystalline form. In the morning it was found that the rim had fallen from the burner to the floor in atoms. The subject deserves careful investigation. [*Nature*, xiv, 561.]

The Scintillation of Stars in Connection with Weather Changes, which has been the subject of many interesting observations by Humboldt, Arago, Seechi and others, has lately been carefully investigated by Resphigi. The chief results arrived at, after a discussion of 1820 observations made during 230 days on seventy different stars, are as follows:—The intensity of scintillation, measured by a special instrument devised for the purpose—the scintillometer—increases invariably with the occurence or approach of rainy weather. The scintillation is, on an average, stronger in winter than in summer, but increases with the arrival of moist weather at all seasons; it increases, also, not only on rainy days, but one or two days before, decreasing immediately after the rain has ceased. Moreover, the intensity of scintillation increases during strong winds, and when the barometer is falling. A thorough and extensive system of observing this phenomenon, will doubtless prove of great value to the science of meterology. [Abr. from *Nature*, xiv, 562].

Pantopollite.—One of the German dynamite manufactories has lately been producing a cheap sort of dynamite which is called pantopollite, the peculiarity of which resides in the fact that it contains a small percentage of naphthaline dissolved in the nitro-glycerin. The purpose of this addition is stated to be in order to prevent the formation of the disagreeable nitrous vapors during explosions. The results of practical tests with the material seem to have been quite unsatisfactory. [*D. Industrie Ztg.* No. 41, 408.]

—There is a statute imposing a fine of $500, or a year's imprisonment, for wanton injury or destruction of trees, and yet fire fiends are permitted to spread devastation ever thousands of our forest acres, and timber consumers are allowed to recklessly waste as much as they use for the demands of commerce. [*Lumberman Gazette*, viii, 307.]

MISCELLANEOUS.

Relation of Brain Weight to Mental Strength. Daniel Wilson has lately published a contribution to the above subject, which formed the topic of comment before one of the recent meetings of the ST. LOUIS ACADEMY OF SCIENCE. The result reached by the author is that there appears to be no definite relation between brain-weight and mental ability. While many great men have possessed large brains, many have also possessed comparatively small ones, while other large and apparently healthy brains are almost wholly inactive.

Mr. Nipher remarked that the same could be said in regard to bodily weight and muscular work. Evidently, in both cases, the achievement depends, not only upon absolute capability, but also upon the disposition to work.

India Rubber. Consul Green, reporting on the trade of the Brazilian provinces of Para and Amazonas, states that the crop of india-rubber, which was little over 2,000 tons in 1861, has been steadily increasing ever since, and reached 6,763 tons in the year 1875. He is able to add that there are vast rubber-yielding districts which have never yet been touched, and that if the rumors that the old districts are becoming exhausted should be correct, there is no reason why the yearly collection should not, in ordinary seasons, continue the steady increase it has shown for some years past, so long as there is an outlet for the produce in the European markets. The increase in 1875 was less than usual, but he observes that this was owing to an exceptionally long rainy season and much sickness, and must not be taken as a criterion of a diminution of population or any unwillingness of the inhabitants to work. [*Colliery Guardian*].

CENTENNIAL NOTES.

IMPROVEMENTS IN THE SEWING MACHINE.—THE VERTICAL FEED.

When the original sewing machine of Elias Howe, Jr., is examined, one cannot but notice that the vital principles embodied in the first successful attempt are still used in all the machines manufactured to-day, to a greater or less extent; this is especially true of all but one machine, which it is proposed now to notice. Just as surely as the same points that made a success of the original model are at this time better applied and fitted for the work required of them, so there must be new movements perfected that will ultimately take their place, for to cease improving is to retrograde out of sight. True, it is always said that each one is claimed as best; but as the "Davis Vertical Feed" is so entirely new, and appears so meritorious, we must leave a description of its principles, without unnecessary comment, to answer all questions. As will be seen by the title, "Davis Vertical Feed Sewing Machine," a feed from above the goods is the "feature," and is covered by patents owned by the Davis Company of Watertown, N. Y., which claims that the machine now manufactured by it and called the "New Davis" will do better work with less operating skill than any other machine extant.

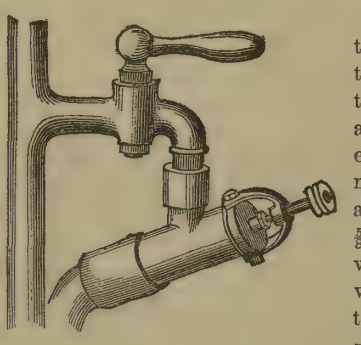
The feed is perhaps the most important point connected with any sewing machine, as upon its accuracy of movement depends the regularity, strength, evenness and perfection of stitching; heretofore this has been accomplished by a wheel or step under the material, and which moves and pushes the goods forward while the needle is raised, and the presser-foot exerts its full force to keep the fabric stationary. It is claimed that the glaring fallacy of this principle will not admit argument in its favor. It truly seems obvious that as the feed moves it must carry the under ply faster than the upper, for the simple reason that the presser-foot retards or holds back the upper ply while the feed forces the lower forward, causing the fulling or gathering so often noticed, and greatly interfering with the evenness of stitch.

The "vertical feed" is arranged above the shuttle-plate, the goods resting upon a smooth surface, and being held firmly down by the presser-foot until the needle has penetrated the fabric, at which time the pressure on the fabric is transmitted from the presser-foot to the vertical feed-bar, which comes down on the goods just behind the needle; so that at the time the needle has reached its lowest point the full pressure is on the feed-bar, at which time the needle and feed-bar are *both* moved laterally the desired length of stitch, the two moving in unison at their highest and lowest points.

A consideration of these movements will show that, as the presser-foot is always raised from the fabric when the feed takes place, no resistance is offered to seams or ridges, and there can be no possible tendency to pull the material out of shape or position, and therefore basting is never required. The needle being in the goods and moving with the feed bar renders the feed sure and the stitch uniform—in fact each stitch finishes the work in itself. They are always the same in length in turning curves, long or short, in either direction; while all other feeds lengthen, turning one way, and shorten turning the other. And again, the needle being in the goods when the feed is made, it is impossible to full one piece and stretch the other. These points will be greatly appreciated in all intricate stitching, bias work and curved edges, as the machine will sew just as the work is placed without basting, and presents no roughness to catch the most troublesome fabrics, and alter their relative positions; hence the reason that those not highly skilled in machine-sewing can avoid the difficulties heretofore experienced, and produce a class of work that has been till now out of the family reach. And again, in this connection it will be noticed that the feed bar is behind the needle, making it capable of sewing elastic goods, giving a smooth and flexible seam, alike on both sides, and enabling the sewing of any number of thicknesses without basting. This feed adjusts itself to the material, which it is claimed none other does in the least, operating with equal facility on heavy or light fabrics, and giving no trouble in passing over great changes in thickness; for example, it will sew through in rotation, and with a small needle, two plies of muslin, eight of cloth, a piece of quarter-inch lead, and finish on a single ply of lace, without showing any visible difference in length or appearance of stitch.

The Franklin Institute awarded the Scott Legacy Medal to this machine. All acquainted with Philadelphia institutions will recognize this to be about the highest distinction attainable. It is quite appropriate therefore that the International Jury at the Exhibition should have confirmed the above award, and alluded to the Davis Vertical Feed Machine thus: "Its ingenious construction, allowing it to perform the largest range of work; its good workmanship, its finish and the good material used in its construction." HY. C. HUNTER.

MINIATURE TURBINE.



One of the smallest motors capable of being put to practical use is the water motor shown in the annexed engraving, and exhibited at D 78, Machinery Hall. It consists of a tube 3 inches long and $\frac{5}{8}$ inch outside diameter, with an oblique inlet by which it can be screwed to the hydrant or faucet. A small stem with a double pulley at the end is projecting from the upper end of the tube, and is rapidly revolving when the water is turned on. A rubber hose drawn over the lower end of the tube conveys the water off after performing its duty. By an endless cord the motion can be transmitted from the pulleys to a sewing machine or any other machine requiring only light power for driving. The motor is constructed on the principle of turbine wheels, and can be run with water pressure of 10 to 15 lbs. to the square inch. After entering the tube by the inlet, the water first passes a stationary wheel having a series of radial vanes of such a shape as to give the water a spiral motion. Issuing from these vanes, the water strikes against similar vanes of a wheel that is fastened to the above mentioned spindle, and which, by the impact of the water, is made to rotate.

Different sizes of this motor are manufactured. The smallest size, of the dimensions above stated, furnishes sufficien power to drive sewing machines, etc.

For circulars and other information apply to the inventor, James Haworth, 626 Arch St., Phila. H. B.

BEYER BROTHERS' MACHINERY FOR THE MANUFACTURE OF SOAP AND PERFUMERY.*

(French Section, Machinery Hall.)

"The importance of the fancy soap trade in Paris invests all the machines and tools used in this branch of manufactures with a peculiar interest. The apparatus exhibited by M. Lesage divides the mass into segments of fixed weight, which may be varied at will, according to the special requirements of the prevailing fashion in the perfumery trade. The paste, while still in a soft condition, is placed in a metallic cylinder, and then, by means of a piston, is ejected through an orifice of a particular shape. The stream of soap resulting from this forcing operation is automatically divided by the machine into lengths, the section whereof determines their weight. These lengths can be varied at will by a very simple adjustment of the mechanism, A small rammer then forces the lengths of soap into a brass mould, where they are shaped and marked as may be required. The machines of M. Lesage are well designed, and very commendable in point of workmanship."

Before proceeding with the detailed examination of the new and improved machines of Messrs. Beyer Frères, reference may be made to a continuous action soap-mixing mill, which was introduced by M. Lesage two years after the exhibition of 1855. The leading feature in this mill was a rotating disc fitted with spiral arms, revolving at their greater diameter in the spout of a hopper into which the soap was fed in chips or shavings, and at their conical portion within a chamber bored out to a like cone. This chamber was fitted with a draw-plate at its extremity, which delivered the soap glossy and smooth, in an endless sausage-shaped stream. M. Brunot, the immediate successor of M. Lesage, modified the arrangement of this machine, without, however, changing its principle. In order to simplify its construction, he replaced the rotary screw-shaped disc by a simple cylindrical or conical spiral, adjusted to revolve with great precision within a bored metal cylinder, and otherwise fitted with the same accessories as mentioned above, except that a grating or screen was fixed to the mouth-piece between the Archimedean screw and the draw-plate.

Messrs. Beyer Frères have in their turn made fresh improvements in this machine, adding the stopper and the mouth-pieces, known by the name of *Filières-Beyer* (Beyer's draw-plates), of which they are patentees, and which have largely contributed to the efficiency of their well-known *Peloteuses* (mixing mills). The Archimedean screw, the most important part of their new mill, has a progressive set of threads. It is surrounded by an envelope, which is simply a parabolic conoid. The threads of the screw are set in such a manner that their generating line drops perpendicularly down upon the corresponding surface point of the paraboloid. This forward set of the threads is designed to secure a better travel for the soap. The efficiency of this apparatus is well proved. Specimens of these improved and combined action machines were to be seen at the Paris Exhibition in 1867, at Lyons in 1872, and at Vienna in 1873, where the jury awarded two Medals for Progress to the makers.

We now propose to give an account of the machines for making toilet and ordinary soaps, as well as of some others employed by wholesale perfumers in the preparation of certain substances used in their trade. Visitors may remember having seen some of these apparatus at work at the Vienna International Exhibition, in that portion of the buildings which bore the name of "The Prater Soap Works." If toilet soap is to be made by means of the machinery introduced by the Messrs. Beyer, care must be taken that the blocks of rough soap to be wrought into the finer sorts do not exceed eight square centimetres in size. These blocks are subjected to the action of a so-called planing machine, fig 1,

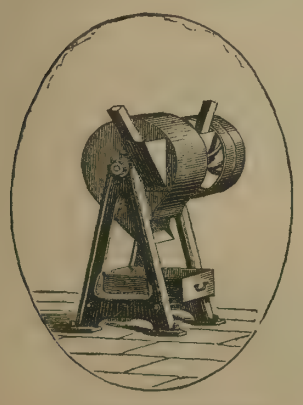


Fig. 1.—Steam-power Planing Tool.

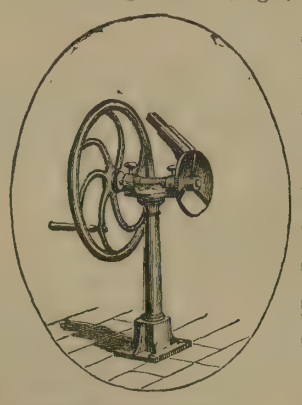


Fig. 2.—Hand-power Planing Tool.

which throws off the soap in the shape of very thin shavings, thus expediting the drying process, and facilitating the amalgamation of the soap with such coloring matter and scents as it may be desired to mix up with it. This machine consists of two twelve-bladed discs fitted to a horizontal shaft, working in a cast-iron frame. Two slides take up the blocks of soap, which are then cut into shavings and dropped out, through an opening situated underneath the machine, into a collecting box.

Once reduced to shavings the soap is ready for the grinding process, whereby is obtained a homogeneous paste, the particles of which are thoroughly well mixed together, and, in addition to that, a perfect combination of the paste with the coloring matter, the essential oils, and scents which are to be incorporated with the soap. After this operation we find the paste soft, unctuous, and close-set. The four-cylinder grinding mill illustrated, fig. 3, is a machine of ingenious design.

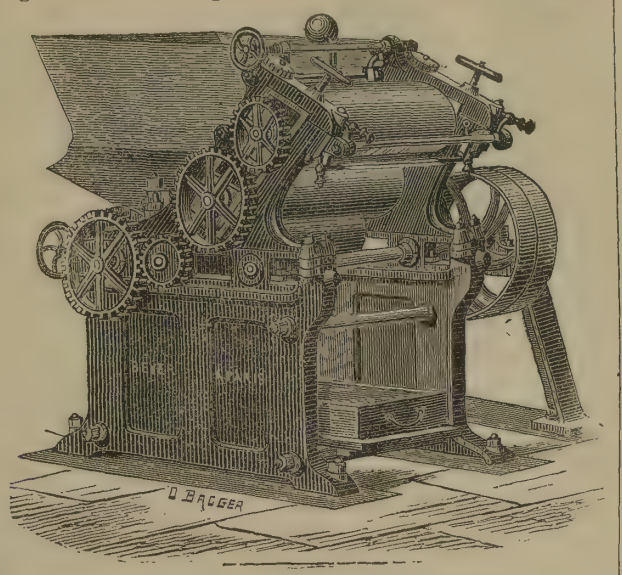


Fig. 3.—Four-Cylinder Grinding Mill.

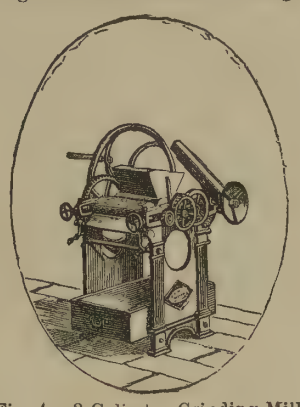
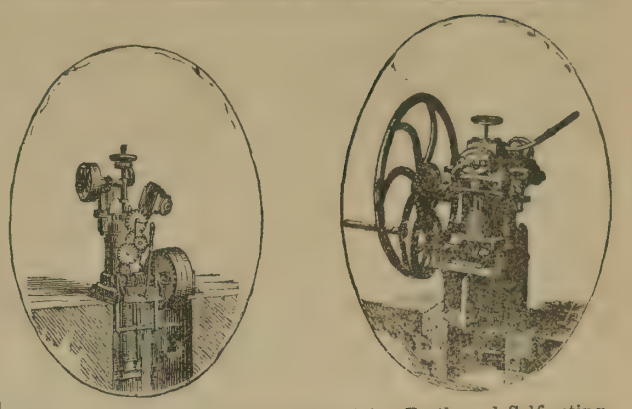


Fig. 4.—3-Cylinder Grinding Mill.

The paste, having been subjected to the action of four granite cylinders, is brought up again automatically in the following manner. The grinding process begins at the bottom and rises in an upward direction, and the paste, after passing between the two lower cylinders, is taken up by the upper ones, and the fourth cylinder—that is the one at the top of all—is so arranged as to throw off the paste into the upper portion of the hopper; so that, in point of fact, the services of a special attendant are entirely superseded, and one man will be quite equal to the task of watching over a series of these grinding mills at work. The same paste is passed as many times as may be neccssary between the cylinders of the machine, and at every turn a toothed cutter is made to divide the mass, so as to secure a more perfect and thorough mixture. The following are the advantages claimed for this machine :—Saving of labor; expeditious production; avoidance of the waste attending repeated manipulations; uniformity of degree in the grinding of the paste.

At this point, when the paste has been thoroughly well ground, it is passed on to a third machine, which has received the name of *Peloteuse*. This machine stretches and draws out the paste and prepares it to receive the shape into which the soap is to be moulded, and the name and impressed trade mark of the soap works. The *Peloteuse* supersedes the processes of scraping, washing, and drying, and admits of rapid or rather instantaneous production. This last is unquestionably a very great advantage, considering that before this machine was brought out this class of soap could not be produced without a series of manipulations covering a period of six weeks.

The *Peloteuse*, figs. 5 and 6, consists of a mechanical pestle which packs the soap paste in a metal cylinder, freeing it from air, and then, the pressure increasing more and more owing to the action of a stopper fitted to the mouth-piece, the paste is driven out through the draw-plate of a given cross-section. A self-acting cutter divides the stream of paste, according to the requirements of each particular maker, into lengths of precisely equal weight. A change of draw-plates will give different shapes, and a re-arrangement of the gearing will alter the weights whenever it may be necessary.

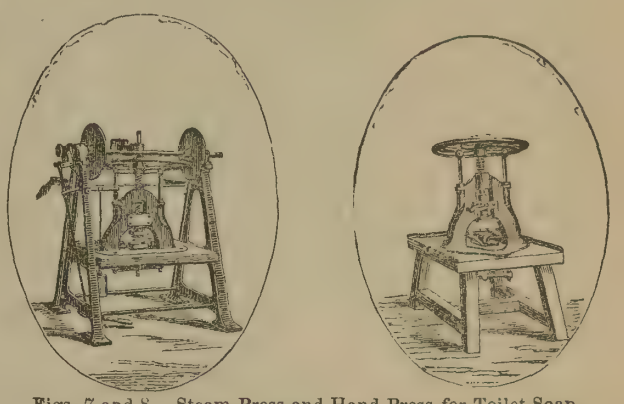


Figs. 5 and 6.—Peloteuses with Revolving Pestle and Self-acting Cutter.

Among the advantages of the *Peloteuse* may be mentioned :—Great saving of labor; rapid production; economy in perfuming material; avoidance of waste; ease of supervision.

The soap thus obtained in segments of predetermined weight and size now needs no further manipulation but shaping and lettering in a mould. These segments of soap, manufactured in a dry state under strong pressure from the stopper, may at once be delivered to the trade. They will keep their form and surface gloss, no matter how long they may be stored.

The shaping or moulding is done by means of the press of which figs. 7 and 8 represent two kinds :—



Figs. 7 and 8.—Steam Press and Hand Press for Toilet Soap.

The press is fitted at the top with a cross-bar attached to the screw, and bearing two rods, sliding into the frame as they cross the table. These rods support at their lower extremity another cross-bar, which follows the upward and downward motion of the screw, so that the soap may be brought up again with ease after pressing, and leave the mould unhindered. A catch arrangement stops the screw in its upper position at the interval of rest. In the steam press the bars of soap may be pressed in any of the three moulds in use for the purpose, viz. :—

In the mould shaping without waste;

In the mould used for various weights; and

In the mould shaping to fixed weights, in two boxes of two compartments each.

Such is the machinery required for the manufacture of toilet soap. It will be observed that here we have described merely combined action machines. But these machines may be made to any pattern to suit the requirements of a large, a medium, or a small factory. For example, Messrs. Beyer make, in addition to the two-disc planing tool, another machine of the kind, but fitted with one disc only, and worked by hand power, fig. 2. Besides the 4-cylinder grinding mill, they have a hand-power 3-cylinder grinding mill, fig. 4, and a large coupled 3-cylinder mill with slanting frames, fig. 9. The same remarks apply to their *Peloteuses* and presses.

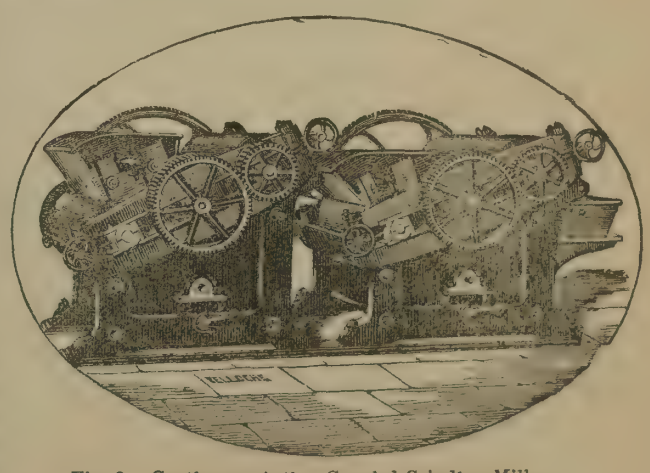


Fig. 9.—Continuous Action Coupled Grinding Mills.

[To be continued.]

* From the *British Trade Journal*,

KELLY'S SECTIONAL SAFETY STEAM BOILER.

[Built by the National Iron Works, New Brunswick, N. J., and exhibited in Boiler House No. 3.]

"In the construction of steam boilers the paramount consideration should be the nearest possible approximation to perfect safety, but with regard to the mode of formation best calculated to secure that end much difference of opinion exists, and will doubtless continue to, even among the most experienced engineers. This much, however, will be conceded by all who are practically conversant with the subject—that the danger of an explosion is in direct proportion to the diameter of the cylinders or tubes, the quality and thickness of metal and amount of steam pressure being equal.

Hence it follows that one most important element in exemption from danger is to be found in the reduction of the diameter of boilers; and no competent engineer will deny that there are peculiar advantages attending the formation of boilers in separate sections, connected as a whole, and thus distributing the strain over a large superficial area

There have been innumerable attempts to put this unquestionably correct theory into practical shape, but in the majority of instances the degree of success has been but partial, owing not to any defect in the principle, but to faulty workmanship. One great trouble hitherto experienced with sectional boilers has been the difficulty of preventing the joints from leaking after being in use for some time. This tendency to leakage was occasioned by the rigid fastening of the tubes at both ends, and as their contraction and expansion was unequal, great strain was unavoidably thrown upon the joints, and leakage was the natural and inevitable result.

This, and most other objectionable features in boilers of this description, are claimed to be completely removed by the mode of construction adopted for the Kelly Sectional Steam Boiler, herewith illustrated. Fig. 1 shows its general exterior appearance, and Fig. 2 the formation of the tubes and their interior operation.

The tubes are made of lap-welded wrought iron, and being but three inches in diameter, if a rupture should occur, it would merely be the giving way of a single tube, resulting in the gradual emptying of the others, while the small quantity of water or steam contained in each tube or section should render an explosion of a destructive character simply impossible. The size of a boiler of this style depending upon the number of component sections, it follows that a large boiler should be just as safe as a small one. Every section is stated to be tested, by the application of hydraulic pressure, to four hundred pounds per square inch.

That part of the boiler with which the fire comes in contact is composed of wrought iron tubes, and especial provision is made in order to obviate the evils of unequal expansion and contraction, both of single tubes and sections. The tubes are fastened at but one end, and consequently expand or contract independently of each other. This is claimed to be a feature of great superiority over boilers with tubes fastened at both ends and sections rigidly bolted together, causing great strain through unequal expansion and contraction, thereby resulting in rapid deterioration, and frequent leakages, and involving constant repairs.

Another important characteristic of these boilers is the facility with which examination and repairs can be made, for while the highest degree of durability is claimed for these boilers, they are of course subject to the inevitable wear which time will produce in their working parts; and to meet this they are so constructed that one or more new sections can be inserted, if requisite, without materially disturbing the brick work, and in a very short space of time. The joint of the tubes with the cast iron chamber or receiver is made by screw threads, and any tube can be removed and a new one substituted very quickly, or by simply taking off the paneled plate an entire section can be taken out without disturbing the others or in any way injuring the brick walls. The valves for the feed water, and also for the blowing off, are in front and easily accessible.

Economy in fuel should be assured from the fact that the entire surface of the tube is a generating surface, of a most effective description, as the heated gases come in direct contact with all the tubes; differing in this respect from ordinary boilers, in which but a small portion of the heating surface comes in direct contact with the fire. As the water is in the tubes, and not around them, as in many other boilers, a greater amount of generating surface is obtained in proportion to the amount of water.

It is sometimes desirable to have surplus storage room for water, and the fact that sectional boilers ordinarily carry but a small quantity of water has often been urged as an objection. In this instance the difficulty is designed to be obviated by having a cylindrical tank of wrought iron in rear of the tubes, so far removed from the fire as not to be affected by it; and by using one or more of these tanks any requisite amount of water can be carried. The tank may be so placed that the gases on their way to the chimney shall pass around it, thus utilizing the waste heat.

The rapid circulation of the water should tend to keep the tubes clean and bright, causing all sediment to be held in suspension until expelled from the blow-off pipe. This should prevent the formation of scale and add to the durability and efficiency of the boiler, by constantly bringing fresh particles in contact with the generating surface to replace those converted into steam. This rapid circulation is secured by the peculiar arrangement of a diaphragm in each tube, and by the internal construction of the front chamber or receiver. Each tube has its independent circulation, the steam generated by each being released from the water as soon as it reaches the front chamber, thus insuring a free and speedy exit of steam.

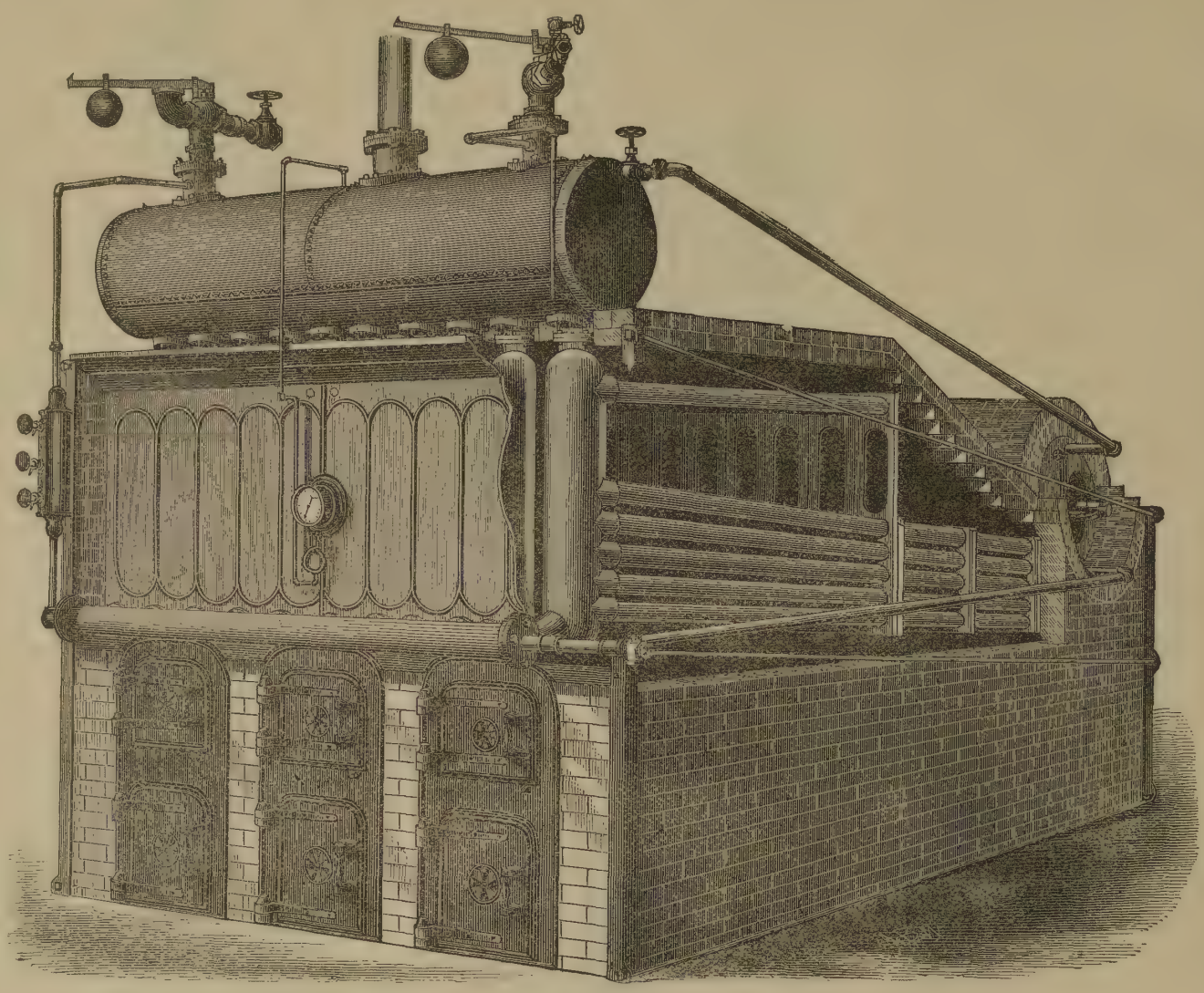


Fig. 1.—WM. E. KELLY'S SECTIONAL STEAM BOILER.—BOILER HOUSE No. 3.

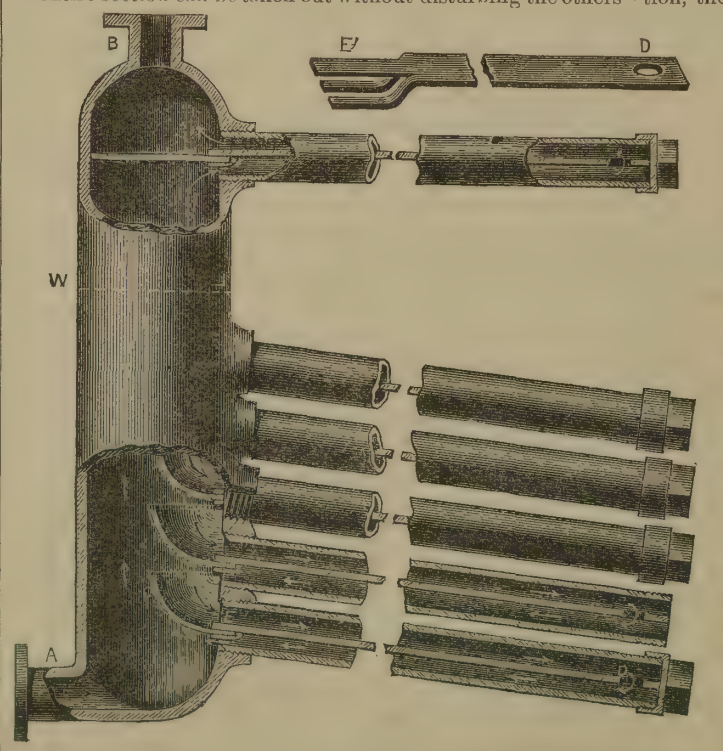


Fig. 2.—VIEW OF THE TUBES, WITH PARTITION PLATES AND FRONT CHAMBER, INTERIORLY.

Fig. 2 gives a sectional view of the tubes and front chamber, and a perspective view of the partition plates, affording an idea of the entire internal construction, which is alike in each section. W is the vertical front chamber, connecting all the tubes, which incline downward at an angle of about seven degrees. The tubes are screwed at the upper end, while the lower is closed by means of a cap, permitting no connection; therefore each tube expands or contracts independently, and any one may be removed without disturbing the others. The feed water enters at A and the steam outlet is at B.

These inclined tubes are always full of water, the water line of the boiler being at W L. The heat first comes in contact with the lower half of the tube and the steam is directed, by the interception of the partition plate E D, along the outside pocket of the front chamber and thence to the dome, first passing through the horizontal pipe, whereby it becomes superheated. Without some such special means of superheating, sectional boilers are very apt to make moist steam.

These boilers are very easily transported by sections, and can be readily set up and put in operation. They are adapted to all purposes where steam is required, and have been satisfactorily tested in various parts of the country, numbers of them being in constant use. The design is tasteful and compact, and when properly set the general appearance is extremely attractive."

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, NOVEMBER 11, 1876. NO. 19.

FIG. 1. STONE CRUSHER AND SCREEN IN OPERATION.

THE TELFORD PAVEMENT.

In our article on Roadways, published in that issue of this journal bearing date of March 10th, the essential requisites for a good roadway were defined to be hardness, firmness, with a certain degree of elasticity, and that condition of surface which should give just sufficient roughness to afford foothold, while offering no practical resistance to traction. Freedom from noise and dust; ease of cleaning and repair; low first-cost; and impermeability to noxious liquids, were considered as *desiderata*, the attainment of all of which seemed impossible or improbable in road constructions.

Our previous article was devoted more especially to city pavements; we shall now consider somewhat briefly the question of general roadways, with particular reference to that system of construction which bears the name of its orignator, Telford.

The recent appearance of Gen. Q. A. Gillmore's excellent treatise on "Roads, Streets, and Pavements,"* by far the most practical and popular work with which the writer has met—renders useless a detailed treatment of the question of road construction, in these columns.

It will perhaps be best merely to recapitulate the most approved modes of road construction; and to repeat that in general, the surroundings and other circumstances play such important parts in influencing choice as to what system to adopt, that while the Telford appears to be by far the best system of road-construction with which we are acquainted, and which has stood the test of severe and continued use, each of these systems has its merits of adaptability to certain localities, and which are worthy of notice.

We shall on this occasion pass by the roads of earth, corduroy, plank and gravel, and confine our attention to those employing more enduring material in their construction.

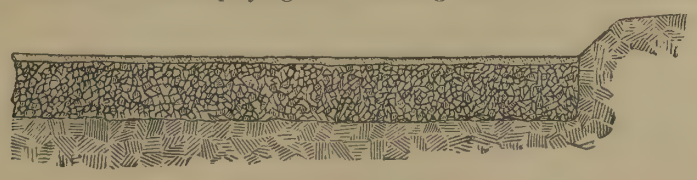


FIG. 2. MACADAM ROAD.

The Macadam road, shown in section in Fig 2, is constructed of broken stone in successive layers, of which the upper, at least, should be of tough hard quality—as more resistant to wear, and permitting of smaller sizes being used—thus giving hardness and smoothness. Macadam's matured practice excluded stones over 3 oz. in weight (say cubes of 1½ to 2 inches in diagonal) and excluded splinters. On the French "Macadam" roads, however, the smallest pieces are used. Perhaps in the mean between these two usages we may find that proportion of small fragments which will best compact or "bind" under rolling and wear.

The cut, Fig. 1, shows, without explanation, the mode of use of the Blake Crusher (described in full in our Centennial Notes, page 151,) with screening attachment, in the manufacture of all grades of broken stone roads.

*258 pp. 12mo.; D. Van Nostrand, N.Y.

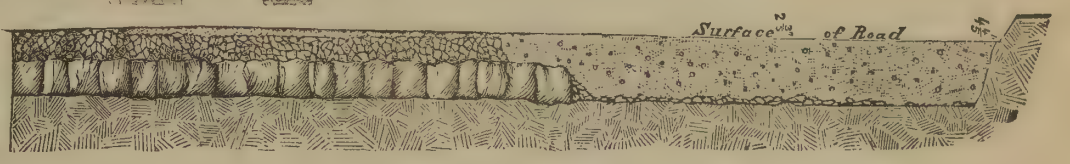


FIG. 3.—TELFORD ROAD.

The Telford Pavement proper (see Fig. 3) has a sub-pavement of stone blocks beneath the upper layer of small broken stone. It thus differs from the Macadam in preventing the forcing of the stones into compressible soils, and in preventing the soil from rising (in wet weather) in the voids between the stones; and in providing drainage for itself.

Fig. 3 shows a transverse half-section of a road 30 ft. wide; having gravel wings and Telford centre.

The foundation stones are about 7″ in depth, and closely set; placed upon their broadest edges and lengthwise across the road. The interstices are filled with stone chips. Upon this foundation rests a layer of stones decreasing in size until the top material is composed of the "crackings" or fine chips left by the crusher.

It is perhaps needless to remark that, for the bottoming, there may be used softer stone than for the top layer, which last must be of a hard tough stone.

Where there is an abundance of stone suitable for bottoming, but unfitted for Telford surface, gravel may replace the broken stone, in the middle layer, and may be given a facing of broken tough stones. If the latter be unattainable, the stone facing may be replaced with gravel.

The Telford pavement proper is often greatly improved by a *sub*foundation of rubble stones placed flat-wise and filled in and levelled up with chips and spalls. On this a layer of sand or gravel is set; and on the whole the Telford bottoming and upper layers are placed.

Fig. 4 shows a road section where a rubble stone foundation is coated directly with gravel.

FIG. 4.—RUBBLE FOUNDATION—GRAVEL FACING.

There are cases where the foundation is so elastic that even the Telford bottoming and rubble foundation will fail to give sufficient rigidity. In such case, the use of a grouting of hydraulic concrete between the stones of the rubble foundation, will remedy the evil. In such case, the rubble stones should be set somewhat apart, as shown in fig. 5; and the concrete (of hydraulic cement, and gravel or stone spalls) well filled in and rammed, so as to give firmne s and immovability to the whole.

FIG. 5.—RUBBLE AND CONCRETE FOUNDATION.

In the construction of the roads described above, as also of nearly all roads, good and constant *rolling* is essential. Particularly is this the case with the Telford. Constant and heavy rolling, preferably with steam rollers (such as those of Aveling and Porter, Rochester, England, and shown at the Centennial), compacts and binds each layer, while fixing the foundation. We thus have homogeneous metalling, incapable of disturbance by weather or traffic; and with a surface affording safe, easy, and economical traction.

Of the roadways above named, the Telford possesses the most marked general merits. Its surface affords excellent foothold for horses, and at the same time the ease of traction therein is worthy of special note; the resistance to traction being, according to Morin, but 23 per cent. of that on the earth road, and but 30 per cent. of that on a gravel road. The broken stone surface is best kept in repairs by minute daily applications, upon roads of moderate traffic. Where traffic is unusually heavy, the wear augments much more rapidly than the traffic; and partial and periodical additions are necessary to maintain the requisite thickness.

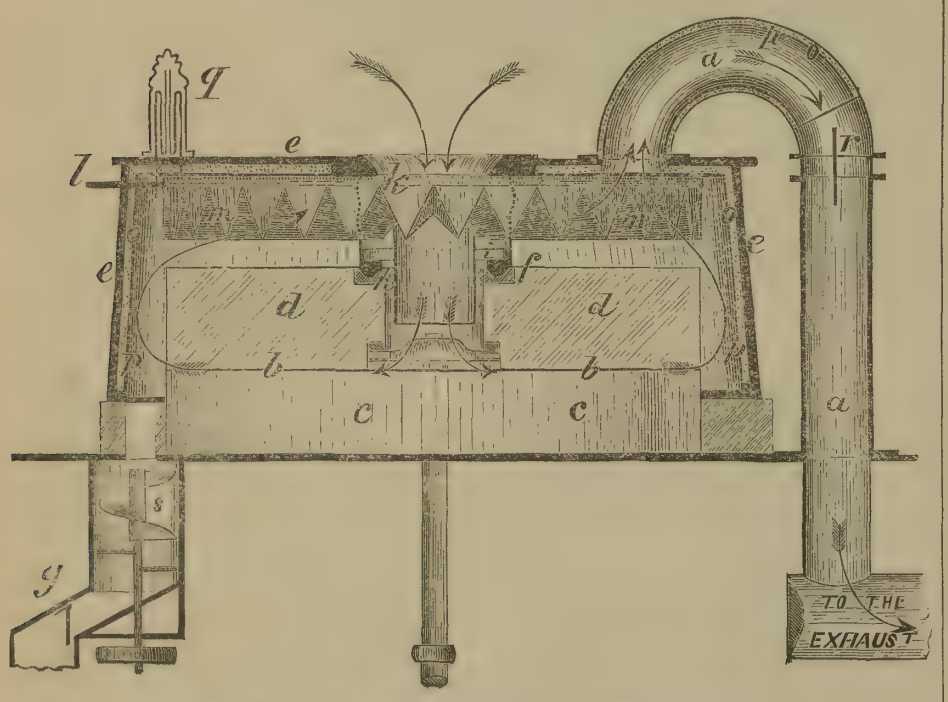
While the Telford road is comparatively free from dust and consequently from mud, even in the most unfavorable weather, it should be kept clean and free from dirt, by sweeping (not with too stiff a brush or broom) and by hoeing with *wooden* implements.

The Telford road permits of a maximum grade of 1 in 20; although a maximum of 1 in 34 is preferable. Thorough surface drainage of the road should be provided for by longitudinal sloping; and also by making it highest in the middle—the most advantageous form of cross-section being, according to Gillmore, "two planes gently sloping towards the gutters, and meeting in the middle of the road by a short connecting convex surface." This is preferable to a convex road, as avoiding the tendency for carriages to keep in the centre and wear ruts therein.

The convexity mentioned is best obtained by uniform surface coats, using larger foundation stones in the centre, where, too, there is the greatest travel, and the most need for heavy foundation.

The longitudinal grade may be almost 1 in 125 in level country. Where there is a long section of descending grade, and in the depression between an ascending and a descending grade, there should be "catchwaters"—broad shallow paved ditches discharging into the side ditches, and crossing the road at right angles, in a depression, and diagonally or V-wise, on slopes (the angle of the V pointing up hill). Sunken catchwaters may be replaced by gentle ridges of the same outline.

G.



BEHRNS' HIGH-PRESSURE ASPIRATION FOR MILLSTONES.

Among the improvements in the art of milling that have been recently brought to our notice, there is Behrns' device for ventilating millstones, an invention especially deserving the careful investigation of those interested in the manufacture of flour.

The following description will be readily understood: *cc* and *dd* are the stones, the upper one being the runner, and *bb* the grinding surfaces. A fan exhausts the air through the pipe, *a*, from the millstone hoop, while fresh air re-enters through the eye of the millstone and passes between the grinding surfaces, as shown by the direction of the arrows in the engraving. In order to make the supply current of fresh air as strong as possible, the hoop is made air-tight, and suitable connections and fittings are employed for the inlet as well as the openings of the chop discharge. For the inlet this is accomplished by means of two V-shaped cast iron rings, well fitted together. The lower ring, *h*, is fastened to the running stone, while the upper one, *i*, is riveted to a leather cylinder suspended from the top of the hoop. A small chain fastened to the side of the upper ring prevents it from turning. The discharge opening prevents likewise the entrance of air at that point by means of the flap valve, *g*, as well as by the chop itself, which is pressed by the revolving screw, *s*, downward through the inclined part of the discharge pipe, and forms there an air-tight mass while the valve *g* is held open. By this means it becomes possible to draw a strong current of air through the grinding surfaces of the burrs, which is designed to keep the meal or chop perfectly cool during the process of grinding.

It will readily be seen that such a strong air-current must necessarily carry with it a considerable quantity of flour dust, which would find its way through the exhaust fan unless provided against. In order to retain this flour dust within the hoop, the following device is applied: Over a light iron framework, *m* is stretched and laced up, in zig-zag shape, a cloth of long-haired flannel. The frame is suspended by three hooks under the top of the curb, and the flannel is tacked loosely, but dust-tight, against the top, at the outer and inner diameters of the frame. The nature and texture of the cloth are such that, although it detains every particle of flour dust, it allows all the warm air and the vapor generated by the dampness of the grain to pass through freely. The dust, therefore, gathers under the cloth, from which it is loosened and drops into the chop by slightly tapping the pin, *l*, at occasional intervals, the suction valve, *r*, being closed for a moment to allow the dust to drop off freely.

The condensation of the vapor within the hoop, as well as the choking of the dust catcher, is prevented by lining the entire hoop with a non conductor, *o*, composed of felt, and which is covered over with galvanized sheet iron. The upper, curved part of the exhaust pipe, *a*, is also protected in the same manner, so that the condensation can commence only when its effect will be harmless. The vapor, on being condensed into water, will pass with the air current through the exhaust fan and thence to the open air.

A double vacuum gauge, *q*, is placed on the top of the curb or hoop, and shows the rarefaction of the air both inside and outside the dust-catcher. The time when the dust should be taken off is thus indicated. The intensity of the current of air, which may be regulated by the check-valve, *r*, is also accurately determined by the vacuum gauge *q*.

The advantages which are obtained by this invention are numerous and important. The old method of ventilation permitted only a moderate current of air to be passed between the stones, on account of the great loss of flour dust incurred by a strong current; but with the use of this aspiration, as strong a current of air as could possibly be desired for cool grinding is easily produced, and is not attended with the loss of a particle of flour dust. It is also evident, that by its use the capacity of a mill can be considerably increased. In preventing the condensation of vapor, this apparatus causes the formation of paste to cease, and no trouble from this source with conveyers, elevators and bolting cloth is experienced in the mills where this ventilation is employed, besides obviating the fires and explosions arising from the accumulation of flour dust of the former system. The flour produced with the aid of this apparatus, being of superior quality and more durable, is favored by the bakers.

In this city, Messrs. Detwiler & Welsh have this improvement in operation on five pairs of millstones, in the "Market Street Mills" where it is open for inspection. For further information apply to Aug. Brehmer, C. E., 430 Walnut Street.

PLEASE QUOTE CORRECTLY.—A very large number of Centennial exhibitors and others have availed themselves of our accurate and more or less extended notices of their manufactures, by using, or quoting from these articles, in their business circulars. In some instances, we know that from 20,000 to 50,000 circulars or pamphlets, thus quoting our descriptions and comments, have been printed and distributed. We fully appreciate the compliment, and the advertisement which these notices give, to THE POLYTECHNIC REVIEW; but we must insist upon such quotation being *verbatim;* and enter our protest against any change in the wording, unless plainly indicated. There are a number of cases where the words "possibly," "the makers claim that," etc., have been omitted from the text; while in others our qualified assertions have been altered to definite statements; or our enumeration of advantages has been given, while faults which we had pointed out were unmentioned.

There was once printed an edition of the Scriptures in which the word "not" was accidentally omitted from the seventh commandment. It is needless to remark that the amendment is not endorsed by the Law Giver or by his followers.

Concerning our own articles, we object to even trivial and unimportant changes, and protest against having opinions not our own fathered upon us by omission, addition or alteration.

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Of these numbers, we may instance No. 17, containing Mr. ROSE'S article on the Harris-Corliss Engine, and Dr. WAHL'S editorial on the Lowe Water Gas Process.

Those to come, and which have been definitely determined upon, are those containing MR. ROSE'S article on SAWS AND SAWING; MR. GRIMSHAW'S series on SAW MILL APPLIANCES; MR. HAUG'S on "THE CORLISS ENGINE AND ITS CONGENERS;" PROF. THURSTON'S on "LUBRICANTS;" MR. GRIMSHAW'S on "BRICKS AND BRICK MAKING;" PROF. SWEET'S on "TOOLS AND THEIR USES," etc.

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WILLIAM H. WAHL, PH. D., ROBERT GRIMSHAW, PH. D., } EDITORS AND PROPRIETORS.

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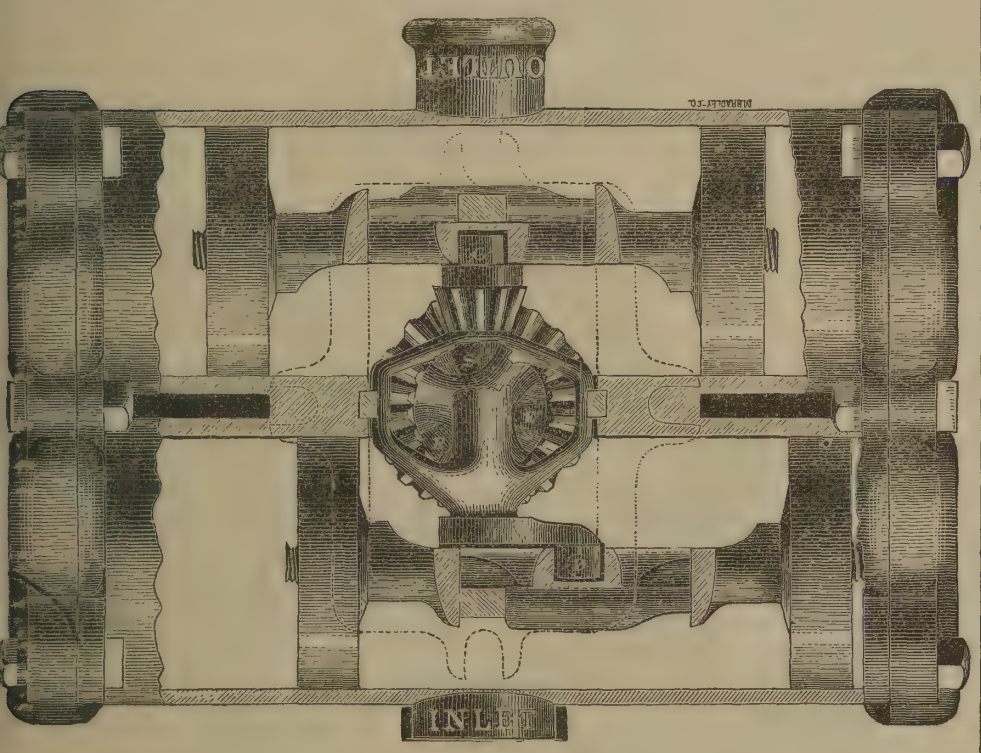
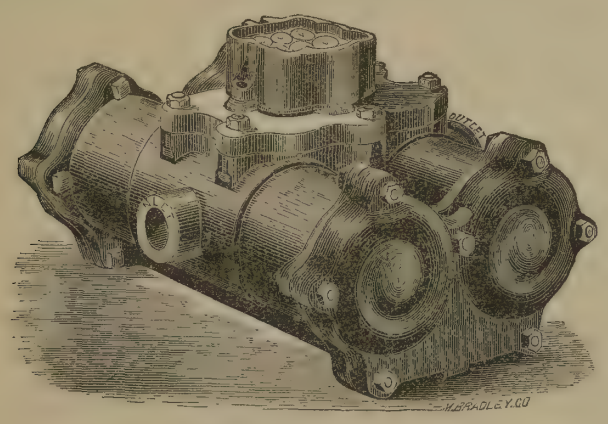




WATER METERS.

III.

The Union Water Meter Co., of Worcester, Mass., which manufactures the Ball & Fitts' Piston Meter, furnishes us with the following: "This meter has now been tested in actual use for the last eight years in a large number of cities in this country and the Canadas. It is in use in all the cities referred to in your previous article in this journal, on page 123. There are now about 6,000 of these meters in use in the several cities thus named. It has won a good reputation for accuracy of measurement and for life of wear.

This meter was produced after much experimenting by its inventors, the Messrs. Ball & Fitts. It is of the double-acting piston class, and hence a positive measurer in marked distinction to the entire class of rotary meters that are merely inferential. This distinction is fundamental; and is a condition that necessitates a different mode of construction throughout from that followed in the inferential class. The work done by the piston meter is actual measuring; the result of the action of the usual rotary is a mere inference, about which there is always a shadow of doubt as to its exact truthfulness. In the piston meter the register may always be applied upon the outside; on the rotary it can only be used inside, without disturbing the uniformity of its work. The piston meter in its action is an engine of power as well as a measurer of water; and hence its counting register can be placed upon the outside and run without any serious disturbance of the proper action of the meter, by reason of the friction of the stuffing-box around the spindle, which drives the register. In the Ball & Fitts' meter the flow of the water into and out of each cylinder is regulated and controlled by a single rotary valve; the requisite number of ports being arranged in one piece of metal. This valve is nicely ground to a conical seat; thus, as it wears, the valve fits itself into the seat instead of being loosened away from it. The movement of the valve is rotary, always revolving in one direction. In the work performed by the meter, two cylinders are filling and two discharging at the same time. The peculiar arrangement of the ports in the valve is such that two ports are opening and two closing at the same time; and in this operation at least one full port is constantly open. This feature is of great importance in the action of the meter, as it permits of a change of piston from filling to emptying, with the least possible pulsation or reaction; and at the same time ensures the uniform and steady flow of the steam. These several, features combined with other devices, ensure the positive action of the meter, and enable it to work accurately under all the varied conditions of heat and steam; its variations from accuracy being slight, whether used in a family by the necessary intermittent action of a domestic service, or when worked uniformly at a required rate of delivery. This feature is the ground on which its good reputation is based.

Many persons still look with disapproval upon the use of water meters; regarding it as somewhat tyrannical to thus limit the use of an element so necessary to health and well being. Some say that to measure out so free an article as water, is to put a premium on uncleanness, ill-health and dirt. But all such forget that whether a man or a woman is uncleanly or tidy, depends far more upon the mental and moral tendency of the individual than upon the presence of an ocean of water. It is a well known fact that one rightly disposed will be far more cleanly in the proper use of a single gallon of water, than another perperson of a different disposition would be with a good sized river at his command. In any well ordered home, the water that promotes health and cleanliness is that which is properly used for that end, and not that which wastes out of, or through, the fixtures. The *waste* from fixtures is often a positive sanitary evil upon an estate, especially when the wasted water reaches and is pent up in the cellar basement, sub-basement or the foundation of a house. Leaks of this kind have often, by the use of meters, been discovered at times, but which otherwise might have run on for years.

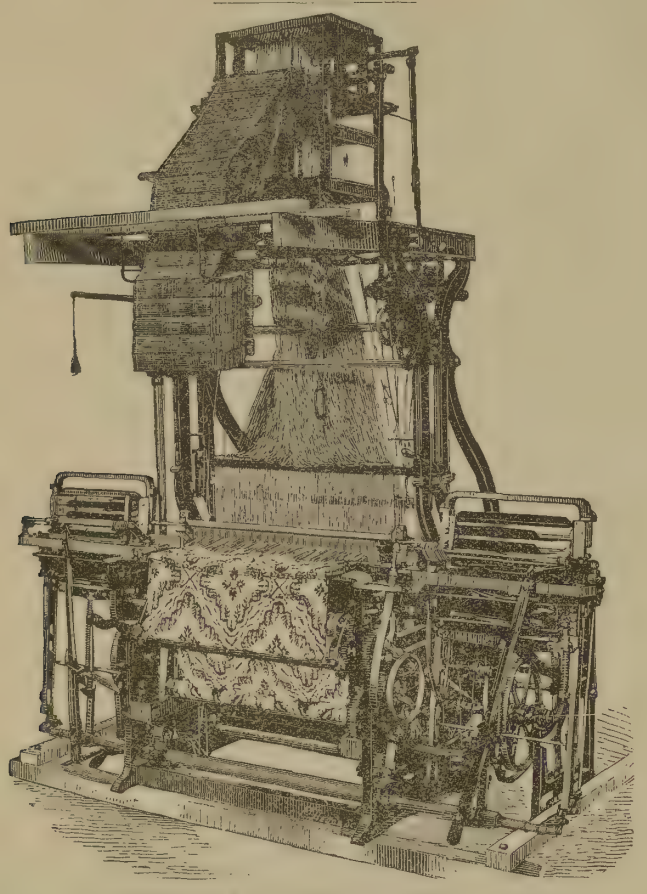
In one sense, the value of any commercial article is only the cost of producing that article. Into this cost enters a complicated list of agents. All trades and professions combine to increase that value. The producer, manufacturer, and common carrier each adds his moiety to increase the value of every article of commerce. Water flowing down the Schuylkill in vast abundance, unretarded by dams or other works of man, is free and valueless. But when raised either by water or steam-power from its natural level and delivered to any freeholder in the city of Philadelphia, through the pumps, reservoirs and conveying pipes of the Fairmount Water Works, every gallon so delivered, then, has a monetary, a commercial value, as much as every pound of tea, sugar, coffee, cotton or wool imported into the city. The cost of the water to any freeholder is his proportionate share of the cost of erecting and maintaining the works. If a freeholder wants for his use coal, flour, tea or sugar, the equitable adjustment of the amount to be paid for the order between the buyer and seller is determined by the weighing scale. A trader would be deemed insane were he to furnish his customers flour on the same principles that water rates are now levied, viz: For a family of six persons, flour for one year, the sum of ten dollars; for a family of ten, the sum of fifteen dollars; or for a house 25 feet front and two stories high, coal will be furnished per year for the sum of eighteen dollars; and if the house be three stories high, the sum of twenty-six dollars per annum will be charged, providing said estate be not of a value of over three thousand dollars; and if said estate be of a value over said three thousand dollars, then the annual rate for coal to be used upon said premises will be increased according to the judgment of the water registrar; and for all vacant lots lying upon a street in which a pipe has been laid, for the betterment to said lot in consequence thereof, will be charged the annual sum of three dollars for each one thousand dollars in value of said lot. To name this mode of supplying the wants of any community, and collecting pay for the various commodities furnished, is to show its hideous inconsistency. Bankruptcy and ruin would speedily overtake any man who attempted to do business on this principle, and yet this is the universal principle upon which the assessment of a water rate is based, where no meters are used.

And one of the reasons why water companies have not become insolvent by the process, is the cheerfulness with which communities, despite all the

grumbling, bear burdens, and the ease with which corporations can borrow money.

A good reliable water meter holds the same relation between the corporation and the consumer of water that a correct weighing scale does between a coal dealer and his customers. It is the final and equitable arbiter between the parties to adjust the question without favoritism, how much has been furnished, and thus supply the true basis on which to compute that which is due from the consumer. This bein the real ground upon which the use of the water meter stands, equitable water assessments cannot be made, nor waste prevented, nor many glaring and flagrant abuses corrected on water works, until their general introduction."

(To be continued.)



THE MURKLAND CARPET-SHADING LOOM.

In this age of growing comforts and facilities for the "house and home," none will admit that the carpet plays an unimportant part. Indeed we have nothing which better combines genuine comfort with a true work of art; the difference between a homely rag carpet and a beautiful ingrain being wholly in the latter point of view. To give the carpet this perfection of beauty, has been the work of a century, involving the highest efforts at artistic taste and of mechanical ingenuity.

As a crowning feature of this period of progress, there appears the carpet-shading loom; by which the abrupt changes of color in the filling, or wool, is made to give place to the most beautiful blending, the carpet yielding its harshness of appearance for softened tints.

This desirable quality is imparted in the highest degree by aid of the Murkland Shading Loom. The appearance of this loom is similar to that of other carpet looms, actually differing, however, in one important feature, viz:—the arrangement of the shuttle boxes. The loom carries 20 shuttle pockets, and, in weaving, will use 16 shuttles, filling the carpet with 16 different colors. The superiority of this will be more apparent when we observe that the ordinary carpet loom is limited to about 6 or 8 pockets, and to 3 or 4 shuttles.

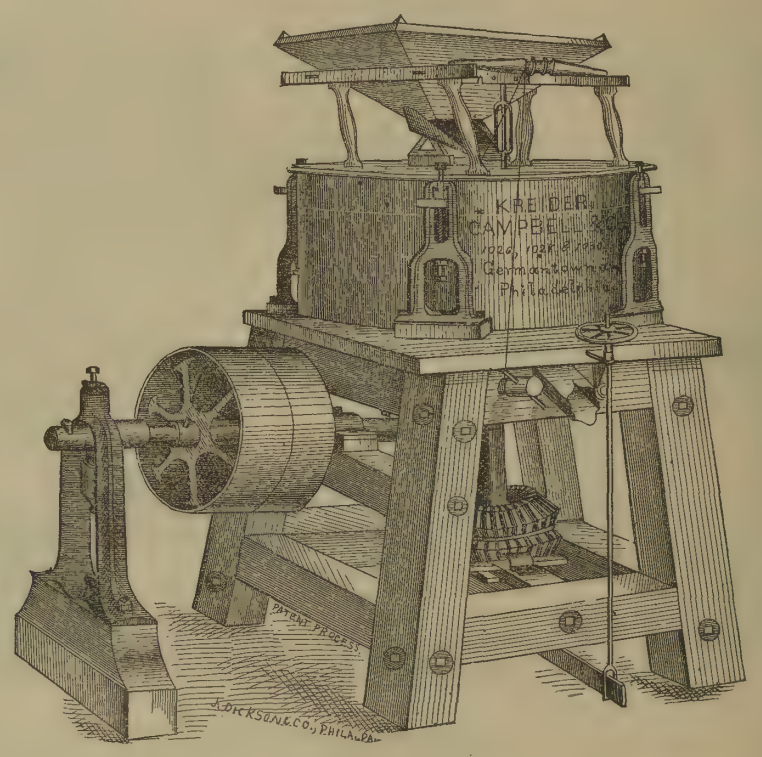
The power of carrying shuttles is extended, in the Murkland Loom, by mounting a large portion of the shuttle pockets on rotating axes; which feature, in reality, enlarges the shuttle carrying capacity almost indefinitely. But in the present case, 7 pockets are arranged in a revolving nest at each side of the loom. Besides these there are three attached in the usual manner at each side, making 20 in all, as above stated; 10 on a side. The construction and mode of operating being the same for each side, it will only be necessary to give a description for one.

The seven pockets of the rotating nest are mounted concentrically on a shaft, and suspended in bearings on the same same slide with the three other pockets, the latter being attached to the slide in the usual manner. The bundle of boxes is located in such a manner that one of the seven forms the fourth box of the row, of which the stationary ones are the upper three. Any one of the seven may take this fourth position by revolving the nest; and this, together with a rising and falling motion of the slide carrying the whole combination, stopping in four different positions, results in bringing any shuttle, carried in the ten boxes, properly before the "picker." Thus two motions are employed in shifting the shuttles, viz: a vertical movement of the whole system, and a rotating motion of the bundle. The former is effected by cams in the usual way, while the latter is produced by a combination of the vertical shifting, with engaging hooks. These hooks consist of notches cut in the side of vertical bars; one on each side of the box-nest shaft. These bars swing about a stationary pivot, toward and from the shaft. Pins projecting from the end of the box-nest pass near these notches, as the slide, carrying the whole system of boxes, rises and falls. Thus it is easily seen that, to rotate the bundle of boxes, it is only necessary to swing one of the notched bars into gear with the pins as the slide moves up or down; rotating in one direction if up, and the opposite direction if down; also we see that these rotations will each be contrawise if one or the other of the opposite notched bars be engaged with the pins. We may therefore have rotation continued in one direction, alternated, or continued in the opposite direction, by simply combining properly the up and down shiftings of the slide, with the opposite engagements of the notched bars. A full vertical sweep will turn the nest-three boxes, or three-sevenths of a revolution; we thus obtain ample control of the shuttles carried in the bundle of seven boxes.

The notched bars, whose action is above described, are thrown in and out of gear by a simple system of levers connected by wires with the needles, which play upon the ordinary card pattern at the top of the loom in the usual way. Thus the pattern controls the action of the needles, and these engage the wires with the harness lifter; the motion of which is sufficient to operate the notched bars. The two notched bars have each a needle, so that either bar may be engaged at any beat of the loom, and consequently the shuttle box-nest rotated either way at any time at pleasure. The two notched bars above described may consist of a single forked bar, as is actually the case in practice, for the purpose of preventing a smash by the possible simultaneous engagement of both.

The shading loom is, from this description, seen to differ from the ordinary loom only in the matter of an attachment, which may be removed, or ignored at any time, if desired, leaving us a good loom shading with fewer colors. And indeed looms are manufactured by the same company with or without this extended shading attachment, the latter increasing the cost only about ten per cent. Hence we see that the loom, instead of being a peculiar and complex affair, useless except for the most elaborate shading, is simply a good substantial loom, accompanied by an attachment which may be put on duty, or not, at pleasure.

Further information concerning these looms may be obtained of Josiah Gates, Esq., of Lowell, Mass., proprietor; or of Messrs. M. A. Furbush & Son, 212 Market Street, Philadelphia, Pa., the present sole manufacturers. S. W. R.



KREIDER, CAMPBELL & CO.'S "FRENCH BURR" GRAIN MILL.

[E-60, MACHINERY HALL.]

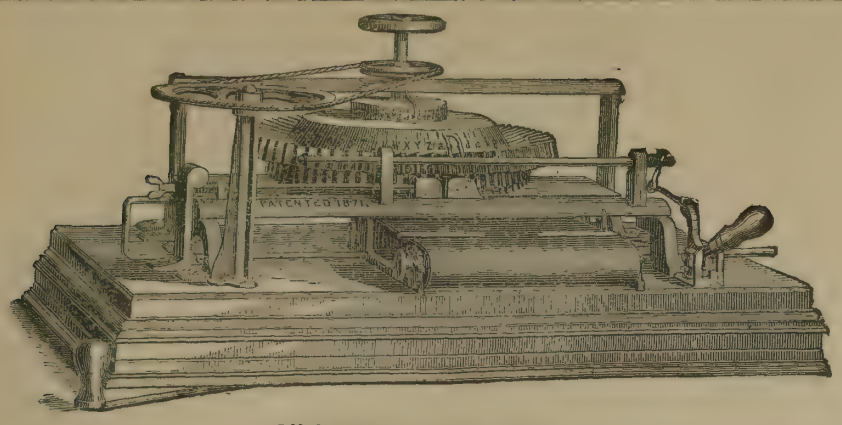
The above cut shows the general appearance of the wooden frame mill, which has some peculiar and valuable features. As may be seen, the power is transmitted by belting, to the pulleys shown at the left of the cut; the horizontal shaft, by suitable bevel gearing, drives the vertical spindle on which the *lower* stone runs. The wheel on the feathered spindle retains its vertical position, while allowing the spindle to be raised and lowered in adjusting the running stone.

The running stone has a variable balance box and driver connected with the spindle, and which is designed to secure equalization of strain in the power transmitted from the spindle to the stone.

There is a "silent feeder," with a conical crusher, to crush the grain before entering the stone.

The mill is of the "under-runner" type; possessing, from this feature alone, important advantages. In our notice of the paint and color mill, by the same builders (see page 152) these advantages in a mill are laid down in detail; but to render this description more thorough, we will say that in the subject of this notice the upper stone is hung and adjusted by the standards and screws shown in the cut; and the lower or running stone, is kept away from the upper by its own weight—thus largely obviating overheating of the flour, while permitting of a much higher speed and consequent increased and superior product.

An advantage perhaps of equal importance with that last named, is that if from inattention, or any other cause, the feed should cease, there can result no contact and consequent destruction, of the burr faces. In the ordinary or "cock-head" type of mill (with upper runners) frequent injury of the faces of the stones results from their mutual grinding action, when, by reason of the cessation of feed, the weight of the upper or runner brings it down upon the bed-stone, while still running. G.



SHILAND'S TYPE WRITER.

[Invented by A. Shiland, M.D., West Troy, N.Y.]

The main features of this machine are shown in the illustration. A revolving disc carrying type-arms, acting vertically in slots formed in the rim or flange of the disc, is moved rapidly by a band connecting with the wheel at the left. The radiating arms vary in thickness and are bevelled at the part where the type are fixed; and when forced down to make an impression, act against the feed-bar, which is moved a distance corresponding to the thickness of each type.

The feed-bar moves the carriage beneath at each impression, and a spring throws it back as soon as the type-arm is raised. The type-arms are held up by a spring acting beneath the arms within the disk. By pressing directly down the key seen at the right of the machine, any letter brought to the index may be printed. The index is applied to the small wheel, on which letters are placed in the order most frequently used. Nine-tenths of the letters required for constant use are shown on about one inch of the circuit of this small wheel.

By a simple arrangement not shown in the cut, the carriage is drawn back after a line is printed, and at the same time is moved a space ready for another line. Spacing between the words is effected by repeating the final letter of each word, when by a slight movement of the operating key to the right, it acts against a stop, preventing the print of a letter, while the feed-bar is moved a sufficient space. A screw at the left end of the feed-bar regulates the spacing, making wide or close work as desired. Several copies may be taken at the same time. The maker claims that the machine is operated with great ease and facility, and that no other machine printing capitals and small letters can be made to do accurate work with the same ease and rapidity as this.

Letters of inquiry may be addressed as above to the inventor, to whom the first letters patent were granted in October, 1871.

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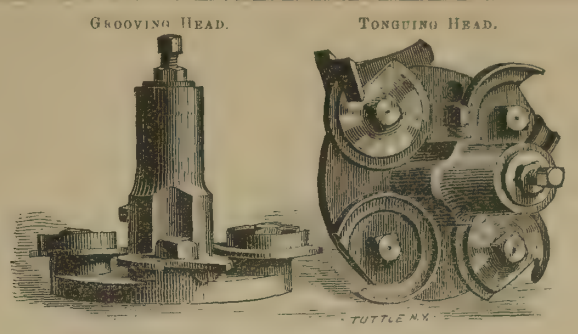

CIRCULAR BIT MATCHING HEAD.

(MADE BY SHIMER & CO., MILTON, PA.)

The firm mentioned has, since May, 1875, been manufacturing a matching head for flooring planers, as represented above, with circular cutters adjustable upon their centres, keeping the heads at all times up to the size made. There are now in use over a thousand.

They are remarkably compact. A six-inch head with one and three-sixteenths spindle, has two and three-eighths bits—nearly all its diameter being spindle and bits with all the weight of the flange and cutters within a space of two inches in height, thus carrying all the weight of the head below, and causing them to run steadily. The firm made first, during the summer of 1873, solid circular cutters, bolted between two flanges, each bit cutting full width of cut. But it is well known that straight bits must be upset when much worn, so also must a circular cutter if brought up to the lumber worked upon in a straight line, the same as straight bits; consequently any bit that needs upsetting or renewing from time to time, will not cut the same sized tongue and groove, but the tongue will become larger and the groove smaller as the bits wear away. This difficulty is overcome by dividing the bits in two parts, one bit cutting the lower half, the other the upper half of the edge of the board, and bolting them by means of a hole in their centres to seat inclined inward and outward, giving clearance to all sides of the cutting edges the same as "spring set" in a saw. The bits being circular in form with the shape of the tongue and groove cut out of their circumferences, should therefore cut the same sized tongue and groove until worn out, and the flooring should always fit alike; and the bits being fastened to inclined seats need not be swaged or filed away to bring out their points. They have slant cutting edges with divisions of cut and should therefore not chip up; the slant on the tonguing head is backward from the centre of the bits; the grooving head is forward, giving more protection to the leading points. These are easily kept in shape by means of a proper gauge sent with each set, by the use of which the heads also remain of one size until the whole circle is worn away. These tools have three to four times more useful cutting edge than straight cutters.

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PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

A Practical Carpet Sewing Machine is still an unsolved problem. The attempt very generally made by most of our large retail carpet houses, of sewing their carpets by machines has had to be abandoned in consequence of unsatisfactorily bulky seams. We believe there are not more than two or three machines used at present in the country. [*Carpet Trade*, Nov.

The San Francisco Water Works.—Richard Ives, of San Francisco, is at St. Louis, and is negotiating with the Vulcan Iron Works for forty thousand tons of iron plates, to be converted into pipe, for conducting water from the Sierra Nevadas to San Francisco, a distance of one hundred and twenty miles. The contract will amount to about two million dollars. [*Hyd. Eng.*, i, 187.]

—It is significant of the change which is taking place in marine locomotion, that, of all the tonnage imported into Great Britain last year, steam vessels represent 12,324,126 tons, as against 10,378,047 tons in sailing vessels; 15,100,991 tons were conveyed in English, and only 7,502,172 tons in foreign vessels.

Gilbert Elevated Railway. The engineer of the Edgemoor Iron Company, in charge of the work now in progress for the Gilbert Elevated Railway Company, stated to a *New York Tribune* reporter on the 20th inst. that the company had finally determined to build the roadway upon Sixth avenue according to the original charter, making the spans reach from one curbstone to the other. The spans will be arched and trussed, presenting a very neat appearance, but they will obstruct the view of the street, and it is thought that the effect upon the value of real estate will be more injurious than were the posts placed just outside the car tracks. The work upon South Fifth avenue was begun again on Wednesday, and is now progressing rapidly. A large amount of the iron prepared for the Sixth avenue portion of the work, upon the short-span plan, is now stored in Brooklyn, and is not to be used unless needed to complete the lines through the lower parts of the city. New girders will be required and will be manufactured at once by the Edgemoor Iron Company. The work on Sixth avenue will be begun soon, and, when finished, the whole structure will be painted a neutral tint. [*R. W. World* vii, 703].

MINING, METALLURGY AND MINERALOGY

A large deposit of copper ore has been found in Berwick and Hamilton townships, Adams county, Pa. It yields about sixty per cent. of pure copper. [*Am. Manuf.* xiii. 26].

A Century of Mining and Metallurgy in the United States. In order that a clear idea may be formed as to the relative position now held by the United States in the world of mining and metallurgy, I have selected the production of coal, which is the main reliance for power of all organized industry, and of iron, which is the chief agent of civilization, as the basis of comparison with other nations, using, so far as coal is concerned, the figures given in the 42nd Annual Report of the Philadelphia Board of Trade, for the year 1873:

	Tons.	Per Cent.
Great Britain	127,016,747	46.4
United States	50,512,000	18.4
Germany	45,335,741	16.5
France	17,400,000	6.4
Belgium	17,000,000	6.2
Austria and Hungary	11,000,000	4.0
Russia	1,200,000	0.5
Spain	570,000	0.2
Portugal	18,000	—
Nova Scotia	1,051,567	0.4
Australia	1,000,000	0.4
India	500,000	0.2
Other countries	1,000,000	0.4
Total	273,704,055	100.0

The following estimate, in round numbers, of the world's present production of iron is taken from various sources, and may be considered approximately correct. The figures for Great Britain and France are those of 1874, and the product of the United States for the same year has been taken. For other countries the estimates are principally for 1871 or 1872, except Austria and Hungary, for which the official returns for 1873 have been taken.

The quantities are given in tons of 2240 lbs.

		Per Cent.
Great Britain	5,991,000	45.2
United States	2,401,000	45.2?
Germany	1,600,000	18.2?
Prance	1,360,000	10.3
Belgium	570,000	4.3
Austria and Hungary	365,000	2.7
Russia	360,000	2.7
Sweden and Norway	306,000	2.3
Italy	73,000	0.5
Spain	73,000	0.5
Switzerland	7,000	—
Canada	20,000	0.2
South America	50,000	0.4
Japan	9,000	0.1
Asia	40,000	0.3
Africa	25,000	0.2
Australia	10,000	0.1
	13,260,000	100.0?

An examination of these tables will serve to show that in the products which measure the manufacturing industry of nations Great Britain stands first and the United States second on the roll, and that there is a clear and almost identical relation between the product of coal and the product of iron. The United States now produces as much coal and iron as Great Britain yielded in 1850. We are thus gaining steadily and surely upon our great progenitor, and in the nature of things, as the population of the country grows, must, before another century rolls around, pass far beyond her possible limits of production, and become the first on the international list, because we have the greatest geographical extent, and our natural resources are upon so vast a scale that all the coal area of all the rest of the world would only occupy one-fourth of the space in which, within our borders, are stored up the reserves of future power. [*Extract from the Centennial Address of Hon. Abram S. Hewitt*, from *Am. Manuf.*, Oct. 26, 13].

NOTE.—The figures of total production given appear to be substantially correct, so far as our general knowledge of the subject, in the absence of a copy of the original paper of Mr. Hewitt, will enable us to judge. But if any of our readers

will take the trouble to add up the percentage column, they will discover a material error. Our contemporary gives the percentage of production of this country as 45·2, and of Germany as 18·2. They should be, for the United States, 18·1, and Germany 12·1 per cent.—ED.

Manganese Bronze. The alloy known under the above name, and produced by the "White Brass Company," in Southwark, is asserted to be characterized by a homogeneous dense granular texture, great toughness and hardness. In color it approaches that of good gun metal, but is more lustrous, and has a gold-like sheen. The manganese appears to purify the bronze of all oxides. From trials made at Woolwich, it is affirmed that in the hammered state manganese bronze exceeds the best wrought iron in strength, and stands in this respect about on a par with steel of soft quality. [*Berg u. Hüttenm. Ztg.*, xxxv, 340].

Ore Reduction in the Bessemer Converter. The following recommendations are made by M. Reduer, of Cruzot, based upon experiments in reducing ores in the Bessemer converter: The introduction of one-half ton of pure iron ore into a charge of seven tons of iron, toward the end of the operation, gave an excellent quality of steel with a clear slag containing scarcely any iron. A better mode has been found to be packing the iron ore around the sides of the converter as fet tling and sintering it somewhat together by a small charge of coke before running in the iron. One ton of ore to six or seven of iron may be used. The advantages claimed are: 1st. Increased cheapness of the steel; 2d. Increased purity of the steel; 3d. Saving in time and fuel; 4th. Possibility of using an iron poor in silicon. The ore used should not contain over 0.07 per cent. of phosphorus. [*Iron Age*, ii, 2, 15].

Steel from Cast Iron. Important improvements have from time to time been introduced by the Foundries and Forges Company, of Terre Noire la Voulte and Besseges, France, for converting cast-iron containing phosphoric impurities, into steel or metal having the properties of steel, and they have now patented some further improvements.

By the improved process of conversion, constituting the present invention, steels of very good quality can be obtained by smelting in a furnace, whether with fixed or movable bottom, or whatever may be the plan of furnace, impure cast-iron containing up to four parts of phosphorus in the thousand, and by refining these cast-irons by metallic oxides, or scoria, or salts, provided that the operation is always finished by an addition of ferro-manganese and ferro-silicium, whose function it is to deoxidize the liquid mass, introducing only insignificant proportions of carbon. By these processes alloys of iron and manganese can be obtained, containing as much as 65 per cent. of manganese, and the use of these alloys render the process of conversion more certain and less costly.

In carrying out the process the workmen take cast-iron containing from one to four parts of phosphorus, in the thousand selecting that which is white by preference; proceed to melt it in a furnace, such as that known as the Martin-Siemens furnace, orother known furnace, either fixed or movable, capable giving the same degree of heat, or introduce the liquid or of semi-fluid iron in one of the said apparatus and proceed to refine it by the successive additions thereto of rich minerals, containing not more than three parts in the thousand of phosphorus; when the refining is so far advanced that the metal only contains traces of carbon, they add to the bath from 1 to 2½ per cent. of ferro-manganese containing at least 50 per cent. of manganese, and mix and run it. Metal obtained by this simple and economical process contains from one to four parts in the thousand of phosphorus and traces of carbon and manganese, and is well adapted for all the uses to which steel is now applied. It is mentioned that ferro-silicium may be substituted for the ferro-manganese when desirable. [*Iron Age*, ii, 2, 15].

CHEMISTRY, PHYSICS AND TECHNOLOGY.

A New and Sensitive Test for Alcohol, suggested by Prof. E. W. Dory, and which promises to be of much practical utility, consists of a solution of molybdic acid in strong sulphuric acid. When brought in contact with this solution, a deep azure blue coloration is brought out, if alcohol is present. The test is affirmed to be so delicate that a quantity of alcohol as minute as the one thousand six hundred and sixty-sixth part of a grain may readily be detected. Prof. Dory in commenting upon the utility of his observation, refers to the frequent substitution of alcohol for chloroform in medical compounds and mixtures, and points out that such adulteration, which may often produce the most injurious effects upon the sick, may be at once revealed by the employment of his method.

Mercury and Aluminium.—A piece of metallic aluminium was accidentally rubbed against some leather from a bag that was contained mercury. The rubbed metallic surface of the aluminium became hot, and in a few moments white. The substance was at first supposed to be an amalgam, but was soon found to be alumina. Probably the mercury formed an amalgam with the aluminium, and imparted to it this property of combining with oxygen when heated by friction. [Dr. C. Jehn, in *Archiv. der Pharmacie.*]

Physical Properties of Gallium. By M. Lecoq De Boisbaudran.—I have recently prepared rather more than half a grm. of pure gallium. In the liquid state this metal is of a beautiful silver-white, but on crystallising it takes a very decided bluish tint, and its lustre notably diminishes. On properly effecting the solidification of superfused gallium isolated crystals are obtained; these are based octahedra, which I am engaged in measuring.

On a first trial (April, 1876) the point of fusion was found between 29° and 30°, or near + 29·5°. I have just examined six samples of gallium *successively* electrolysed from one and the *same solution.* The foreign metals, supposed to be present, ought to distribute themselves unequally among the different fractions collected :—

	Points of Fusion.
Gallium, No. 1, ...	+30·14°
" " 2, ...	30·16
" " 3, ...	30·14
" " 4, ...	30·15
" " 5, ...	30·16
" " 6, ...	30·16
Mean, ...	+30·15

The sample No. 4 was afterwards placed for two hours in boiling water, and the innumerable globules formed were united by compression. The point of fusion had not varied. The metal was therefore very free from potassium. The six samples of gallium having been mixed, a fragment was taken (weighing 2½ centigrammes,) which was kept for half an hour in nitric acid diluted with its own volume of water at a temperature of 60° to 70°. The loss only reached a fraction of a milligramme. The point of fusion remained fixed, for the metal melted *very slowly* at +30·16°, and crystallised *very slowly* at +30.06°. I shall shortly have the honor of submitting to the academy the new process which served for preparing this gallium, of which the constant point of fusion denotes a very satisfactory purity.

In May, 1876, I tried to determine the density of gallium on a sample of 6 centigrammes: I obtained 4·7 at 15° (and with reference to water at 15°). The mean of the densities of aluminium and indium being 4·8 to 5·1, the provisional specific weight found for gallium appeared to agree tolerably well with a theory placing this metal between indium and aluminium. However, the calculations established by M. Mendeleef for a hypothetic body, which seems to correspond to gallium (at least according to many of its properties), would lead to the number 5.9.

Gallium crystallised under water decrepitates sometimes when heated. Perhaps my first metal contained interstices filled with air or water. I am ignorant if this cause of error is combined with others so as to falsify my first determination. However this may be, I avoided it subsequently by heating the metal strongly and solidifying in a dry atmosphere. I then obtained higher densities, varying from 5·5 to 6·2, although the weight of the trial samples did not exceed a few centigrammes.

I finally operated with 58 centigrammes of gallium derived from the union of six samples mentioned above. Density at +23° (and referred to water at +23°)—

First experiment	5·900
Second experiment	5·970
Mean	5·935

The same gallium was afterwards maintained for half an hour between 60° and 70° in nitric acid diluted with its own volume of water, washed, very strongly heated, and finally solidified in dry air.

Density at + 24 45 (and with respect to water at + 24·45°) =5·956. There is no occasion to insist, I think, on the extreme importance which attaches to the conformation of the theoretic views of M. Mendeleef concerning the density of the new element. [*Chemical News*, from *Comptes Rendus.*]

Artificial Diamonds.—Many pastes have been devised for the preparation of these beautiful stones. None have been able in their products to equal the natural diamond in hardness and brilliancy; but nevertheless, to an unpracticed eye, the imitation is so perfect that the difference cannot be distinguished. The following formula for making a diamond paste is said to be one that gives the most satisfactory result. It is called "Loysel's" paste :

Take pure silica.....	100 parts.
Red oxide of lead.....	150 "
Potash, calcined.....	30 "
Borax, calcined.....	10 "
Arsenious acid.....	1 "

This produces a paste which has great brilliancy and refractive and dispersive powers, and also a specific gravity similar to that of the oriental diamond. It fuses at a moderate heat, and acquires the greatest brilliancy when re-melted and kept for two or three days in a fused state, in order to expel the superabundant alkali and perfect the refining. This paste is used not only to produce factitious diamonds, but, besides, other factitious gems, of which it forms the basis. [*Druggists' Circular*, xx, 185.]

Action of Distilled Water on Copper.—Mr. Carnelley has found that distilled water dissolves an appreciable amouut of copper on standing in contact with the metal, even for the comparatively short space of an hour. [*Nature*, xiv, 562.]

Zinc as an Anti-Incrustator.—Having observed in a number of works in Mayence, that zinc, in many cases, hindered boiler incrustation, but in others not at all or very little, Dr. Rautert was led to examine the feedwater, and he concludes from his analyses that the zinc is efficacious where the water chiefly contains gypsum, but that it fails against carbonate of lime. The proportioning of the zinc to the heating surface alone is a mistake; it should rather be proportioned to the quantity of gypsum present. [*Journal of the Telegraph*, iv, 273.]

Vortex Smoke Rings.—During the recent meeting of the British Association, Sir W. Thomson exhibted the vortex smoke-rings. A box about three feet square has a circular hole of about six inches in diameter cut in its front face, and the back is covered by a piece of tightly-stretched canvas or linen. The vapors of ammonia and hydrochloric acid are admitted to the box, which soon becomes filled with the white smoke of chloride of ammonium. A sharp but gentle tap on the canvas back drives out a puff of the smoke, which traverses the room in the form of a beautiful ring. So great a velocity can be imparted to these vortex rings that even at a considerable distance they have sufficient velocity to extinguish candles. The experiment is remarkably simple, and with a little care in securing good ventilation, it may be performed without injury to persons or things in the drawing room. [*Boston Journal of Chemistry*, xi, 52.]

A Grave Question of Water Supply.—Every now and then a scientific pessimist starts up to announce the discovery of a weak point in the arrangements of the universe, owing to which, some æons hence, a terrible catastrophe is to overwhelm this earth and the fittest inhabitants who may then have survived. Now it is a comet, with gradually narrowing gyrations, that is to ram the earth; and now it is the earth itself drawing a few inches nearer the sun in each successive year, or losinge its own heat with perilous rapidity. Hope, however, is almost given to romote posterity by some other philosopher, who has discovered something that acts as an antidote to the other's bane. Probably, before any great damage has been done, some one on the optimist side will be able to reply to Professor J. D. Whitney's suggestion, that this globe of ours is being gradually desiccated. Professor Whitney is a well-known American savant, and he has been putting together a number of facts showing that, over large tracts of the earth, seas have been becoming dry land, and that the rainfall over extensive areas has been lessening, even during the historic period. Central Asia is instanced and there has doubtless been considerable change in the direction of aridity in that region. But may that not be, in a considerable measure, owing to its depopulation, and the suspension of irrigation and the change in the course of rivers that have followed in consequence. The drying up of the shores of the Mediterranean is, no doubt, largely owing to the cutting down of the forests of Europe and Asia, and thus reducing the rainfall, which may also have been the case in Central Asia. In earlier geological periods the distribution of the land and its contour would, as they do now, modify climate. Professor Whitney, however, holds that, setting aside all these and other causes of lesser import, the earth is drying up; but it is more than probable that the desiccation to which he points, and which is undeniable, may be only local and counterbalanced by a more copious rainfall in tropical and other regions, less under the eye of physicists. [*Iron*, viii, 515.]

Oil for Wool Greasing.—A Mr. Lebrun mentions, in a German paper, that a considerable quantity of oil may be saved by the following process of oiling wool, besides insuring a more uniform and regular web, on account of the woolen fibres loosening and separating themselves more easily from each other. Moreover, this plan, it is said, is not open to the objectionable features of some processes, which sometimes cause the total disappearence of fine color dyes; and the cards wear longer and better, besides allowing the wool to be more easily and economically cleaned.

To obtain this preparative, pour into a wooden trough 20 parts of oil, with 10 parts of liquid ammonia, adding five parts of water. Stir up this liquor with a wooden spoon, and, by inserting a steam pipe, allow the snme to boil until the

strong smell of ammonia has evaporated, after which the oiling or greasing may be proceeded with in the usual manner. [*Manufacturers' Review*, ix, 29.]

Use of Chloride of Calcium for Watering Streets.—For some time past it has been proposed to make use of a weak solution of some deliquescent salt for watering the streets of large towns. Chloride of calcium, which has no commercial value, and is even regarded as an obstruction in some works, seems naturally adapted to this purpose. During the last few years trials have been made at Rome, the principal streets of which are watered with a solution of chloride of calcium obtained from the numerous proligneous acid works in the neighbourhood. The results are reported to be highly satisfactory. The dampness communicated to the road, instead of disappearing in a few hours, as is the case when water alone is used, remains for a whole week, the road continuing damp without being muddy, and presenting a hard surface on which neither the wind nor passing of pedestrians or horses has any effect. In the course of time, too, the road becomes covered with a sort of crust which adds to the durability of the surface.

The use of this solution shows a saving over that of water alone, which M. Houzeau, in a recent communication to the Académie des Sciences, estimates at over 30 per cent. The same authority also attributes to this method of watering the streets hygienic qualities which deserve consideration. The chloride of calcium obtained from the pyroligneous acid works always contains appreciable quantities of perchloride of iron and tarry matters, the volatisation of which in the air cannot but be salutary. Lastly, the complete suppression of dust constitutes a considerable improvement in the conditions capable of exercising an influence on public health. [*Jour. Soc. of Arts*, xxiv, 984.]

MISCELLANEOUS.

Monster Umbrellas.—Our contemporary, "*Iron*," referring to the curious badges of royalty, in the form of umbrellas or parasols, which constitute the outward and visible signs of the power of the Sable potentates of Africa, notices the fact that a Glasgow firm has just finished at the instance of a mercantile house of the same city, an order for forty handsome and gigantic sunshades, which are designed as presents to African chiefs with whom the merchants in question have commercial dealings. Three of these palanquins are about 30 ft. in diameter, and the remainder, about 18 ft.; and all are handsomely ornamented. The handles (of lancewood) are armed with a spike for tenting purposes, and have a bayonet-point in the end to render them more portable.

Sleeping Cars for Ladies.—Lady travelers think it would be a great improvement in "wayfaring civilization" if they could be provided with a separate toilet and sleeping car, or separate apartments in cars occupied in part by gentlemen. It is also suggested that female waiters would be more agreeable for ladies than those of the other sex. Theoretically, these points are well taken; but financially they are open to objection. It has probably never occurred to lady occupants of sleeping coaches, that there are many luxuries and privileges that are incompatible with railway transit, and which cannot be provided without a serious disturbance of the relation between receipts and running expenses. To accomplish a journey in the night-time at the rate of forty miles an hour, it is necessary to submit to some trifling inconveniences, or else pay a rate of fare that might seem exorbitant. In order to realize how much more easily and expeditiously night journeying is performed now than formerly, let the ladies try the old stage-coach awhile, and their romantic ideas of civilization will be very much modified. [*Technol.*, vii, 226.]

Rapid Ocean Traffic.—Some extraordinary rapid passages across the Atlantic have been recently made by the steamships of "The White Star" line. The Britannic is really at this moment the fastest ocean steamer afloat, as will be seen from the following record of her recent voyages. Under the command of Captain Thompson, she has for four voyages in succession, steamed from Queenstown to New York, and *vice versa* under eight days, maintaining a remarkable uniformity of speed. The following is the abstract in question:—

Outwards.	d.	h.	m.	Homewards.	d.	h.	m.
Voyage 1876.				Voyage 1876.			
10—June . .	7	16	36	10—June . .	7	19	48
11—July . .	7	19	57	11—July . .	7	22	31
12—Aug. . .	7	20	46	12—Sept. . .	7	22	55
13—Sept. . .	7	17	37	13—Oct. . .	7	16	23
Average,	7	18	44	Average,	7	20	25

On the four outward trips, the Britannic ran a distance of 11,216 nautical miles, being an average of 2,804 per trip, which gives a speed of little over 15 knots per hour, or 360 knots per diem. Homewards she steamed 11,549 nautical miles, or 2,887 per trip, equal to 15·32 knots per hour, or 367·68 per diem. We believe there is nothing on record to parallel this performance. It is fair to add that the success of the ship is in great part due to the efficiency of the four cylinder compound engines, fitted by Messrs. Maudslay & Field to the Britannic. These engines are of the overhead type, the high-pressure cylinder being above the low-pressure cylinder. [*The Engineer*, xlii, 278.]

Chromate of Lead in Ham Coverings.—Prof. Bouchardat, of Paris, in his capacity as member of the Council of Hygiene and Salubrity, recently submitted a report to the prefect of police, in which he pointed out that in a specimen of ham, said to be imported from Cincinnati, the ham was enveloped in a cloth saturated with a yellow substance. This yellow substance proved to be composed of the chromate of lead, a most deadly poison. It was suggested in the report that particles of the substance may become detached and be mixed up with the alimentary substances vended by grocers and others, and thus run the risk of poisoning those who make use of them. By a decree from the police the substances so enveloped were seized and buried under ground, and future supplies are to be treated in a similar manner. Mr. Bouchardat suggested that, if the American purveyors preferred to have a yellow envelope around the alimentary substances they export, the chromate of lead may be replaced by any other yellow substance—turmeric, for instance, which is known to be entirely harmless. [*Sci. Am. Supp.*, ii, 693.]

Slag Paving Blocks. The Birmingham *Post* says: There is now a possibility of the "Staffordshire oysters," as the scoriæ from blast furnaces are facetiously called in this district, being turned to profitable account. Mr. Joseph Woodward, of Bedale, Yorkshire, having patented an invention for making the scoriæ into blocks for road and footpath pavement, has put down a plant at Messrs. Turley's blast furnaces the Factory, Tipton, in order to produce blocks for the purpose. The molten slag runs from the furnaces into molds, which are fixed upon a rotary frame, and as fast as one mold is filled another presents itself to the stream. The molds are opened whilst the blocks are red-hot, and placed in a kiln at a certain heat, and there they stay for 24 hours. This is all the process, and it requires two men and two boys to use up 30 tons of slag per day. When ready for use the blocks are very clean and hard. They turn a chisel, and the inventor claims for them that they are impervious to wet, and, consequently, to frost; the surface is level, but of such a nature that it bites the iron of the horses' shoes; the surface is chamfered, and so no horse could slip, whilst the chamfering provided the street were laid upon a convenient gradient, would render the pavement a self-cleansing one. The blocks are made in five sizes in order to provide for different purposes, are cheap, and Mr. Woodward's effort to utilize the slag is the most successful which has been seen in South Staffordshire and East Worcestershire.

EDITORIAL CORRESPONDENCE.

We have received the following from a manufacturing firm in Pittsburg:

EDITORS POLYTECHNIC REVIEW.—*Gentlemen:* We noticed in your issues of August 26th and October 14th, a fruitless discussion in regard to the comparative advantages of cold punched and hot pressed nuts. Without entering into the controversy, we may be permitted to say that either firm makes a nut good enough for ordinary purposes, and just about the same as a multitude of others have made for the past twenty years. They can pass time much more profitably by discussing the proper proportions of nuts for the various sizes of bolts, as a uniform standard would be an advantage to all manufacturers and consumers. We suggest that the commission of experts appointed by the United States Government to test iron and steel be requested to make thorough tests, and at the same time to recommend a list of sizes which would likely be adopted by the government and other consumers. The result of these public tests might also decide the question of quality, and again remind the public that tests made by interested parties are worthless.

If this course should not be satisfactory to our competitors, we then beg to propose that either or both select the size and quality of iron most suitable for making square and hexagon nuts on their machines; we will use precisely the same iron, and if we do not eclipse both, in point of quality and saving in material, we will pay for the tests; or, we will leave the matter in the hands of five competitors, all of whom they may select.

Very respectfully,
CHARLES & MCMURTRY.

Pittsburg, Nov. 6, 1876.

BIBLIOGRAPHICAL NOTICE.

THE SILK INDUSTRY IN AMERICA.—By L. P. Brockett, M.D. New York, 1876.

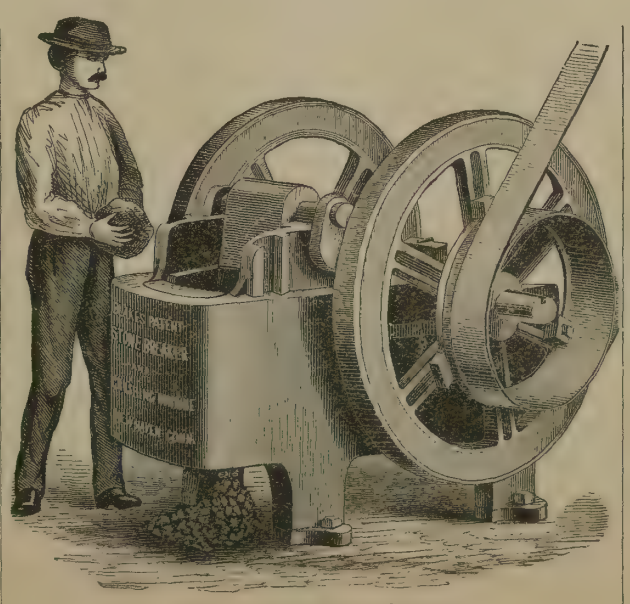
This volume has been prepared in connection with the Philadelphia Centennial, as a record of the progress made by America on this important industry. It is published under the direction of the Silk Association of America. Its contents comprise a full account of the progress of silk manufacture in this country, and of the various establishments devoted to it. It contains many details of the lives and efforts of the pioneers in silk industry, and of the more recent achievements in the manufacture. There are also presented tables of statistics, in great part new and expressly prepared for the work, which show the large mercantile and manufacturing interests involved.

CENTENNIAL NOTES.

THE BLAKE CRUSHER

Performs a work never, before its invention, successfully accomplished by machinery, viz., the breaking of stones, ores and other hard substances into fragments of moderate size. It is used in the construction of roadways, in preparing concrete, in mining operations, and in crushing minerals for various purposes.

It is very simple in construction, but is made strong and massive on account of the great strain and wear to which its working parts are subjected in crushing minerals, some of which yield only to a pressure of over 27,000 pounds (13½ tons) to the square inch. Its principal features are a heavy frame in which are set two upright jaws, one of which is usually fixed while the other has a slight vibratory movement imparted to it by a rotating shaft. These jaws are wide enough apart at the top to receive the stones to be broken, but converge towards each other below, so that at the bottom the opening is only wide enough to permit the fragments to pass when broken to the required size. It will thus be seen that when a mass of stone or ore is placed between the jaws at the top, the vibrating jaw advancing cracks it into two or more pieces; then receding, it liberates the fragments which drop lower down between the jaws, and are crushed again at the next movement of the jaw; and so on until the fragments having been sufficiently reduced have passed out through the narrow space at the bottom.



[Fig. 1. Perspective View.]

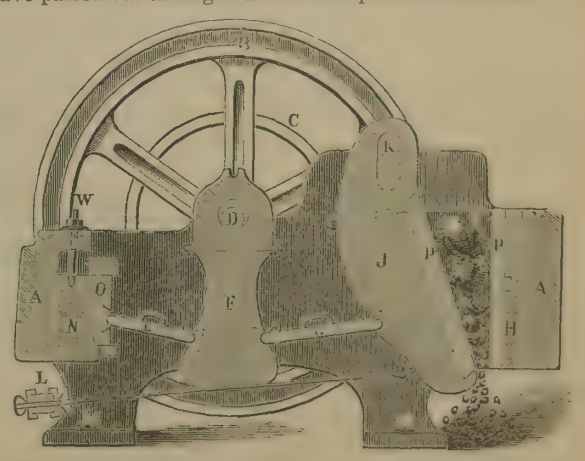


Fig. 2.—Sectional view.—A A, main frame; B, fly wheel; C, driving pulley; D, crank-shaft; F, pitman; G G, toggles: H, fixed jaw; I, cheek; J, movable jaw; K, jaw shaft; L,

rubber spring; N, wedge; O, toggle block; P P, jaw plates; W, wedge nut.

It will be seen that the distance between the jaws at the bottom limits the size of the fragments. This distance, and consequently the size of the fragments, may be regulated at pleasure. A variation to the extent of 5-8 of an inch may be made by turning the screw-nut W, which raises or lowers the wedge N, and moves the toggle-block O, forward or back. Further variations may be made by substituting for the toggles G G, or either of them, others that are longer or shorter; extra toggles of different lengths being furnished for this purpose.

The face-plates of the jaws are made of chilled iron. When worn at the lower end after long use, they can be inverted, and thus present a new surface to the action of the stone or ore, and can be replaced by new plates at small expense.

These machines are made of different sizes, some of them being capable of taking in a stone weighing half a ton and reducing it in five seconds to fragments of five inches and downwards. The opening at the bottom of the jaws may be varied at pleasure, so that fragments of any size may be produeed.

Although a machine for breaking stones and ores has been needed from the earliest ages, and has been attempted by numberless inventors, yet the principle of crushing by upright, convergent, vibratory jaws was entirely unknown before the invention of this machine, all crushing machines before it having been made upon some plan of rollers, rockers, stamps, or hammers. The first patent was taken out by the inventor, Eli Whitney Blake, of New Haven, Connecticut, in 1858, and since that time "The Blake Crusher" has come into use by that name in all parts of the world. Its rapid and universal adoption in industries as old as road making and mining, sufficiently prove (apart from the testimony of engineers and experts,) not only the great want of such a machine, but its originality and merit.

As a labor saving machine also it stands in the front rank. One of the 15 by 9 machines for macadamizing uses, will produce over 100 cubic yards of road per day, the fragments being $1\frac{1}{4}$ inches in diameter and less. This is not only equal in quantity to the work of 100 men, but the quality of the product is far better than of hand labor, because there is enough of fine material in it to make a perfect road surface at the outset. So greatly has the Blake Crusher reduced the cost and labor of constructing broken-stone roads that it has given an immense impulse to these improvements, and hundreds if not thousands of miles of such roads have been already made in the Eastern and Middle States alone, which would never have been attempted without it. Similar results have been effected by its use in mining enterprises. In these also it has not only diminished the cost of reducing the ores, but it has also developed better processes of treatment through the improved quality of its product. And so of other industries. In preparing concrete for instance, machine-broken stone requires 33 per cent. less cement than stone which is broken by hand.

Upon this point of the labor-saving value of the Blake Crusher, on an application for the extension of the patent in 1872, evidence was taken under oath, from parties using the machine in various industries to show the actual saving they derived from its use over hand labor. The extension of the patent was vigorously contested by interested parties, but no attempt was made to impeach the correctness of this testimony. By it, it appeared that there were at that time 509 of the Blake machines in use in the United States (besides infringements), and that at a low estimate these 509 effected a direct saving over hand labor of over *five and a half millions of dollars a year*, or *fifty-five millions of dollars in ten years* (which is about the average life of a machine). This estimate made no account of the indirect benefit resulting to the country through its development of first-class roads and cheapened transportation, nor from new and improved processes in mining operations which owed their existence to this invention, nor from various industrial enterprises which but for it would not have been undertaken, nor any of the benefits which had been effected by unauthorized infringements. When all these are regarded, and the benefits direct and indirect of the invention are viewed in their extension all over the globe and through future years, its merits in an economic point of view will be easily recognized. The distinguished architect and engineer Fred. Law Olmstead, Esq., stated with reference to this machine, in 1872, "the value of the invention has as yet been very slightly manifested, and it will eventually prove to have been one of great national importance."

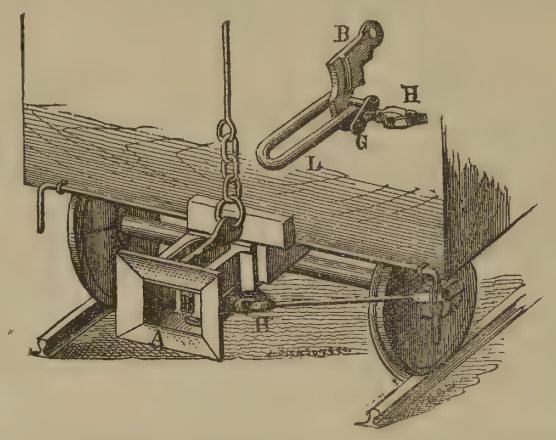
An indirect but very significant testimonial to the novelty and great merit of the Blake invention is found in the fact that, while no crushing machine operating on this principle existed before 1858, more than one hundred have since been brought out by different inventors, and of these over seventy have been patented. The manufacturers claim, however, that all machines which contain an upright convergent vibrating jaw, actuated by a revolving shaft, unless specially authorized by them, are infringements of the Blake patent, which is still in force, and whose validity has been invariably affirmed by the courts in numerous suits.

It is proper to add that the Blake Crusher has received the highest awards as an invention of originality and merit in thirty-seven expositions where it has been shown, including the International Expositions at London and Paris. At the recent International Exposition in Chili, one of these machines exhibited by the Blake Crusher Company in competition with other Blake Crushers made in foreign countries, received the first prize, having passed triumphantly through tests which disabled its competitors. The makers state that it has sometimes happened that the steel heads of sledge hammers accidentally dropped into the crushers have been broken without injury to the machines.

THE PERRY CAR COUPLING.

The car coupling illustrated in the accompanying cut is calculated to prevent the now so frequently occurring accidents to brakemen while in the act of coupling; for it can be operated entirely from the outside, and hence does not require the operator to risk his life by going between the cars.

The cut shows the draw head A fastened to a railway car, and besides, the details in their respective relative position. The connection between the cars is accomplished by a link L, which is held in the drawhead A by a pin B, of a peculiar shape, bearing against ridges of the drawhead A, which reduces the length of that portion of the pin that is exposed to the strain, thus very greatly increasing the strength. Owing to its peculiar shape this pin, when placed in position, will be guided in a circular arc, and for this reason can be raised in a double manner; first by pulling a chain which is attached to an eye of the pin B, and which can be operated from the top of the car; and second, by pushing the lower

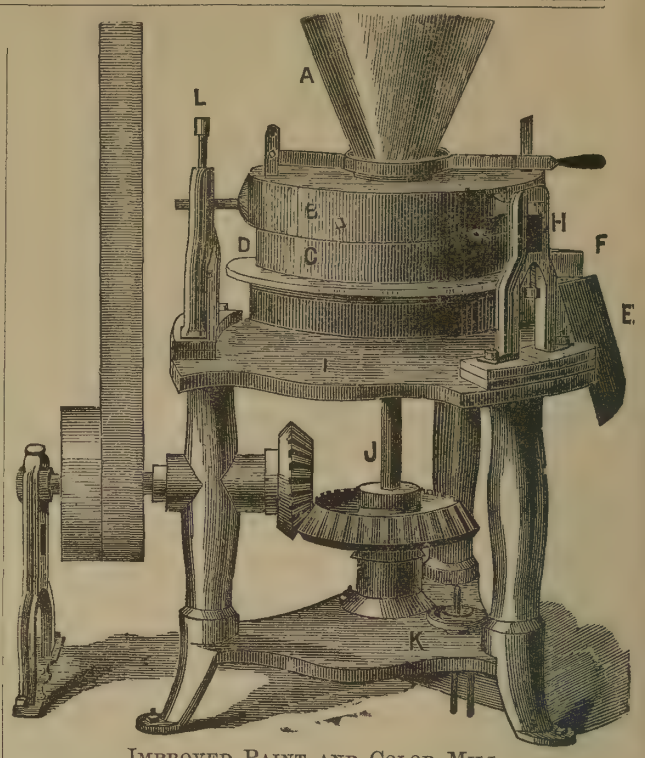


end of the pin in an inward direction. A stop keeps the pin B from being raised higher than necessary.

There is another mechanism, consisting of the double-armed lever G, with pins projecting beyond one side of the link L. This fork-like lever serves to raise the front end of the link, and can be worked from either side of the car by a rod extending across the car, the connection being accomplished by a shorter rod and the universal joint H, as will easily be understood from the drawing.

When the link is pushed into the drawhead the pin will be raised and allow the link to enter, but will then immediately drop down again and lock the link. To couple two cars, the link must first be pushed in one of the drawheads, and then, as the cars approach each other, the front end of this link is raised through the fork G, so as to enter the drawhead of the other car, when it will be locked as described. The uncoupling of the cars is accomplished by raising one of the pins by its chain.

The maker states that this coupler is in operation on the B. & P. R. R. and N. B. R. R., Mass., and on the F. & K. R. R., Indiana, also on the narrow-gauge cars in the Centennial grounds. The model was on exhibition at B 9, Machinery Hall, by W. V. Perry, Kokomo, Ind.



IMPROVED PAINT AND COLOR MILL.

(Made by Kreider, Campbell & Co., Philadelphia, exhibited at E–50, Machinery Hall.)

The cut given herewith shows very clearly the construction and operation of this mill, which is designed to grind smoothly all kinds of paints and colors. The material to be ground is fed into the hopper A, which is removable or adjustable by the lever shown. That portion of the hopper which is below the top of the upper stone, is flaring or bell-shaped, to aid the feeding by keeping the material loose. In this it is assisted by an internal scraper. The top stone, B, is stationary; being hung in the standards H, shown, and adjustable vertically by the screws L. The bottom or runner-stone, C, or spindle J, is driven by the bevel-gearing shown, and supported on the step-plate K. Around and attached to the equator of the runner-stone C, is an encircling iron shelf-band, D, to receive the ground materials, which last are removed therefrom by a scraper F, which sweeps them into the spout E. The standards are of cast-iron, bolted together.

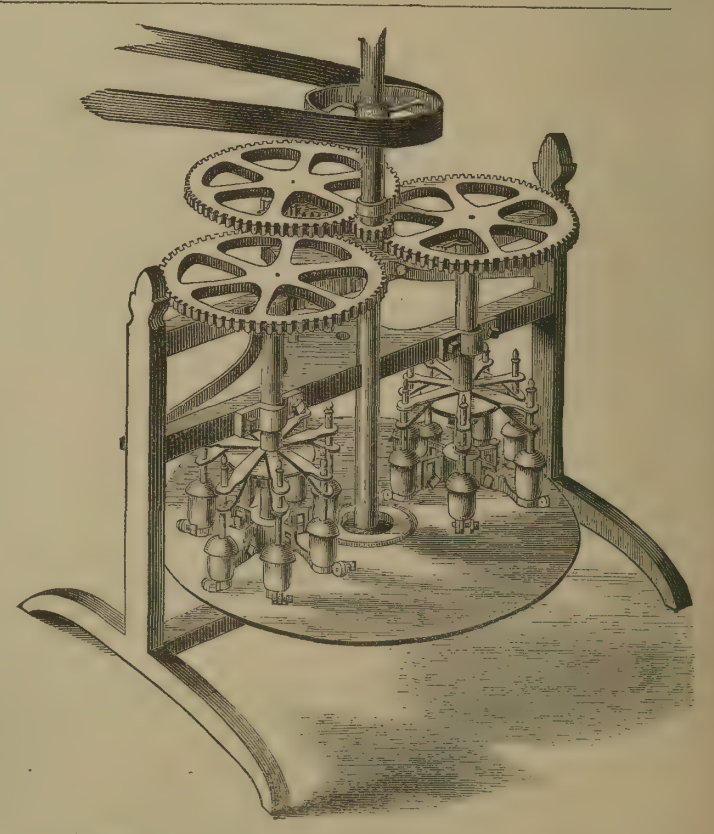
The advantages of having the upper stone hung from the standard, and stationary, and making the bottom stone the runner, are that the feed is facilitated, and the stones do not injure each other in case of being run without feed; as in the latter case the lower stone or runner is, by its own weight, kept away from the upper. Furthermore, a higher speed (and consequent increased capacity) is permitted; while a most important feature is that as the material is not so greatly heated in grinding, the injury from this latter source is diminished—an advaniage especially appreciated in grinding fine reds and vermilion, which are peculiarly suseptible to injury from this cause. G.

KELLY & SAMUEL'S "KEYSTONE" GLASS WARE GRINDING MACHINE.

[Made by Kreider, Campbell & Co., Philadelphia. Shown at E–50, Machinery Hall.]

There are many classes of operations which machinery will perform, not only more cheaply, but with greater regularity and accuracy than can be attained by hand-work.

Where this double inducement exists (as should be the case with the machine herewith illustrated), there can be but little excuse for the continuance of hand-labor. The cut shows a machine having two upright wooden standards with three suitable cross-braces, which last carry the bearings for three vertical shafts, driven by belt and gearing as shown. The central spindle is stepped on the lower cross-piece, and bears an iron disk 52 inches in diameter, and driven 120 revolutions per minute. Each of the other vertical shafts has seven horizontal arms, on the extremity of which are as many spring holders for the flasks or fruit jars to be ground. The flasks being mounted in place, are held by the springs against the revolving disk; and the vertical shafts carrying them at the same time being given 11 revolutions per minute, while the disk being properly supplied with sand and water, we have as a result the even and accurate grinding of the flask mouths, and a perfectly even wear of the iron disk. The supply of sand is regulated from the top of the machine, and the waste sand is received in a box beneath. The makers state that, with two boys as attendants, two different sizes of jars can be ground on it at the same time, at the rate of 44 per minute, or 180 gross in ten hours; this quantity requiring five men's work by the old system. The percentage of loss by breakage is also claimed to be much less than by hand.



The economy of the machine is thus calculated by the makers:

"By actual working one season, we are enabled to present the following comparison between grinding fruit jars by hand and with the machine, viz:

Say two furnaces running 150 days (5 months), making an average of 75 gross per day, will turn out 11,250 gross of jars in one season (of 150 days) and the cost of grinding by hand is about 35 cents per gross, making the total cost of grinding the 11,250 gross of jars, ... $3,937.50

The cost of grinding the same quantity (11,250 gross) on the machine, will be about 10 cents per gross, or a total of 1,125.00

Thereby saving *two thousand eight hundred and twelve* 50-100 *dollars* $2,812.50

in one season by grinding on the machine, to say nothing of the percentage gained by breakage." G.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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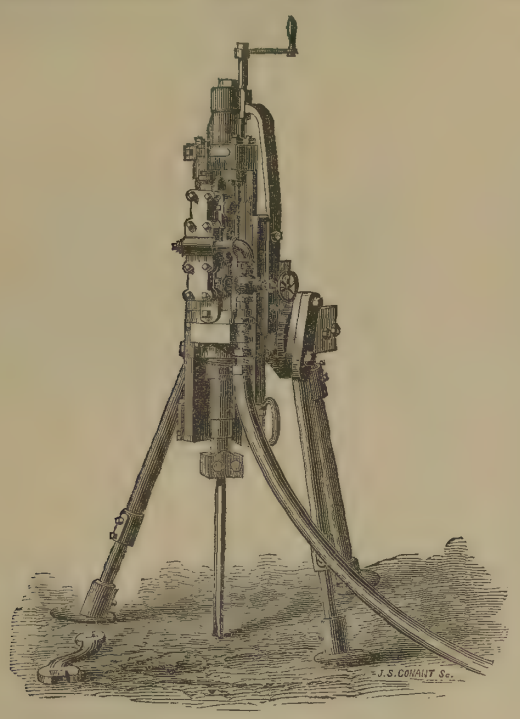

THE BURLEIGH ROCK DRILL.

This is the first successful rock-drilling machine ever used in America, and with the exception of the Sommeiller drill of Mont-Cenis, the first in the world. It was first used in the Hoosac Tunnel, in 1866, after the trial, and utter failure, of several other machines. These machines remained in the tunnel to the end of the rock work, and it is estimated that the time required for completing this gigantic undertaking has been shortened by them between twelve and twenty years. Since the assurance of the practical utility of these machines in the tunnel, they have been extensively introduced throughout the United States, and indeed in many other parts of the world.

Drilling machinery thus marks a new era in the history of rock work, greatly extending the power of man in reducing rock obstructions wherever presented, whether at the quarry, in the mine, or in mountains, blocking up the proper thoroughfares of states and nations.

The rock-drill problem has been a severe one; none other having received the attention of so many able inventors with so few successful results. Only a faint idea of the difficulties in the way is obtained by observing that a rock-drill must be simple, because used by men of low order of intelligence, no others engaging in such work; the parts must be well protected to stand the rough handling; it must be compact, so as to admit of going in any possible corner; it must be undaunted by perfect showers of water and rock-dust thrown upon it from the drill-hole; it should be portable, and ready to start off all right "on the word go," for any possible position it may be placed in, whether directed horizontally, vertically, up or down. Though so simple a thing as a crowbar occasionally breaks when subjected to such circumstances, yet there are some who seem to expect that a drilling machine will never wear out, and much less, break.

While the above-named difficulties would naturally present themselves to the intelligent inventor, in canvassing the preliminaries; there are others which are usually learned by experience, the leading one being the fact that the strongest materials will succumb to the severe and continued shocks resulting from the blows given to the drill; and when solid pieces may endure for a time, built ones will not. The way in which these difficulties have been overcome in the Burleigh drill, will be better understood from a description of the parts.

These machines are in reality complete reciprocating steam or air engines without fly-wheels, accomplishing, automatically, three movements, viz: the striking of blows, the rotation, and advancing. In some cases, however, the latter is aided by hand. The perfecting of the drill has required attention upon four quite distinct devices, viz: a contrivance for each of the above movements, and one for holding the drill, the latter being by no means insignificant. This drill-holder is distinctly shown in all the cuts, and consists of a piece firmly attached to the end of the piston-rod, with a hole for receiving the drill-head, and on each side for some distance, a slit which allows it to be punched upon the drill-head, or shank, by means of two strong bolts, also shown. The drill is thus held firmly to the piston-rod, reciprocating and rotating with it. The blow is given by forcing rapidly forward, by steam or compressed air, the piston-rod and attachments, some 70 lbs. weight for a two-inch drill, the velocity increasing until the blow is struck. The shock thus given the piston and rod, require it to be of the simplest construction, and is usually in one piece, with the exception of the light packing rings. The piston-rod passes through both heads of the cylinder, the latter made very long, serving as guides for the former.

On the rear end of the piston-rod is an annular projection, serving as a cam to operate the vavle gear and feed movement. The valve gear, in all except the smaller machines, consists of a T-shaped lever, pivoted near its middle, and a valve-rod and valve. The cross of the T is placed parallel to the piston-rod, with the branch outward. To the branch the valve-rod is directly attached, so that the rocking of the lever throws the valve. The ends of the T branches are curved inward, and placed near the annular cam above mentioned, so that the reciprocation of the latter with the piston-rod oscillates the former. The valve rod and branch of the T are plainly seen in the cuts; the cross, which is much longer than the branch, being situated in a slot in the casing at the rear of the machine.

The drill is rotated on the back stroke, by means of a stationary annular ratchet, through which the rear end of the piston-rod slides. Inside the ratchet is fixed a spline which slides in a spiral groove along the rod. A click prevents rotation of the ratchet on the back stroke, so that the rod must turn by reason of the spiral groove. But in the forward stroke the drill rotates the ratchet, as the latter turns easier than the former, and the click only holds for one direction. At the side of this ratchet is a second one, with a smooth face and a simple friction break, and carrying a spline running in a longitudinal groove on the rod. These render the rotation positive, even though the ratchets should stick, and the friction brake applied in this case prevents the drill from bounding around irregularly, and leaving deviating ridges in the hole to trouble the drill.

The automatic feed is effected by sliding the cylinder forward in guides or ways, as the hole deepens, by means of a ratchet-nut attached to the rear of the machine, in which is a stationary screw fastened to the frame. The ratchet and nut are turned by a click jointed to a lever, the latter being placed in such a position that the annular cam on the rear of the piston-rod strikes it at the end of the forward stroke of piston. The adjustments are such that the lever is allowed to vibrate just enough to enable the click to pick up one tooth when the cam reaches a certain point at the end of the forward stroke; without reaching this point the click fails to catch the next tooth, and thus the machine only advances as fast as the drill does.

Most of the moving parts are covered by the casing, prolonged from the cylinder towards the rear, and thus protected from dust and accident. This body of the machine proper is carried in a concave casting, on tongue and groove slides. From this casting extends a yoke towards the rear, as shown in the cut, and which holds the feed screw. To this casting is also secured the clamp by which the whole machine is mounted in position for duty. The clamp is usually adapted for holding upon a cylindrical piece which usually forms part of the supporting frame.

The frame for supporting the machine is made differently for different purposes, as shown in the cuts. Light machines are conveniently used on tripods and columns, while larger and heavier ones are put on carriages. In tunnels a jack-screw attachment is a great help for security and steadiness of position.

For driving narrow galleries and shafts, it is convenient that the machine be short. For such purposes a somewhat different valve-gear is adopted; and the feed screw is attached at one side of the machine running in a stationary rut, which modification admits of a great reduction of length. This form of machine is known as the "jumper," and "stoping-drill." Seven different drills are made, varying in dimensions and purpose, including, besides the above, the mining drill; the tunnel drill, similar, but larger than this last; the sewer or sub-marine drill, and the heavy sub-marine drill. For railroad tunnels the drills are carried upon a heavy carriage running on temporary track. This style of carriage is in use in the great Sutro Tunnel of Nevada; and a similar one was, employed in the Hoosac Tunnel.

These machines are manufactured by the Burleigh Rock-Drill Company of Fitchburgh, Mass.

S. W. ROBINSON.

School of Mech. Eng.,
Ill. Industrial University.

Fig. 6.—PAGE BELTING COMPANY WORKS, CONCORD, N. H.

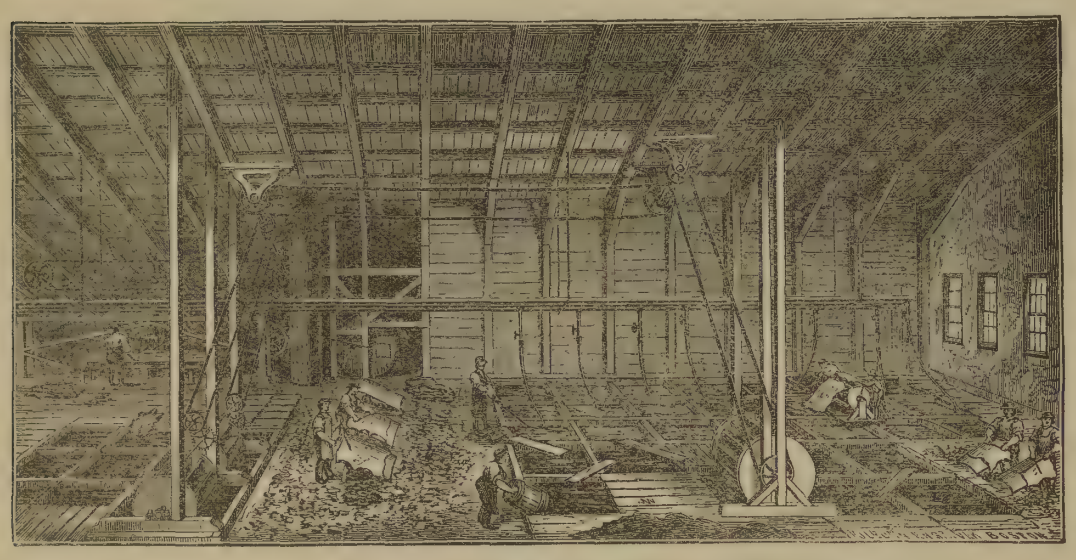

Fig. 7.—BEAM HOUSE.

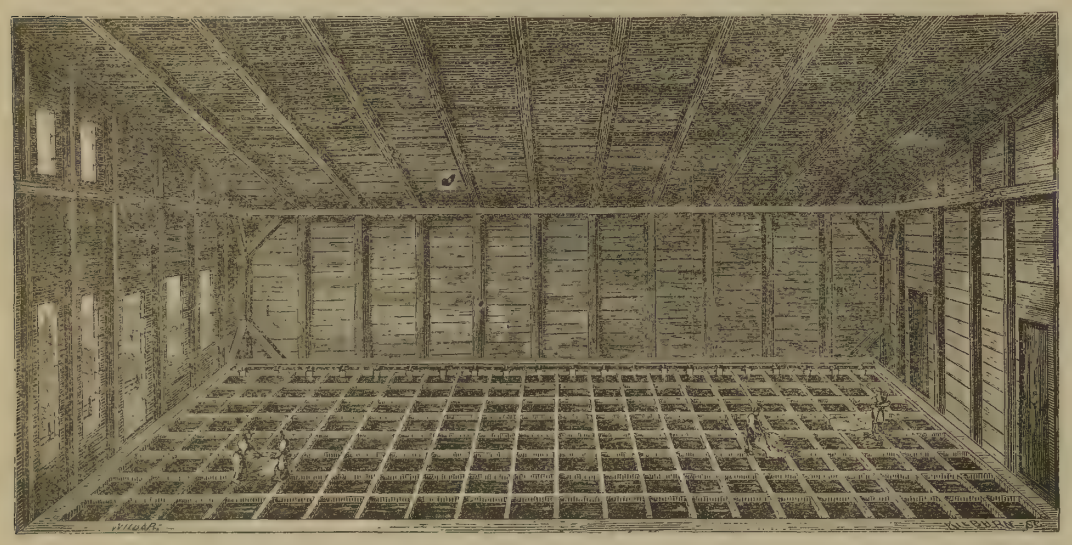

Fig. 8.—TANNERY.

Fig. 9.—MODERN BARK MILL.

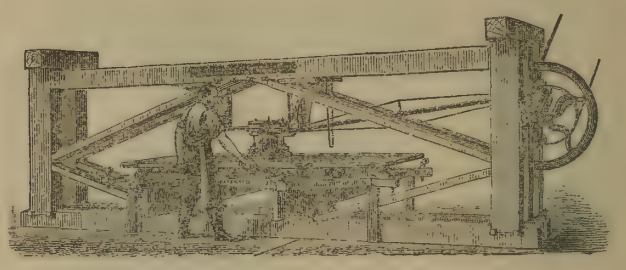

Fig. 10.—FITZHENRY SCOURING MACHINE.

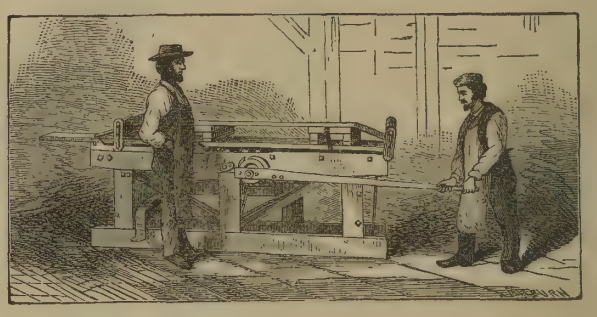

Fig. 11.—MODERN STRETCHING MACHINE.

Fig. 12.—POWER FINISHING MACHINE.

IMPROVEMENTS IN THE ART OF BELT MAKING.

II.

The New Way. For the general view of the establishment taken as an illustration of a modern Belting Manufactory, the reader is referred to Fig. 6, which illustrates the extensive works of the Page Belting Company, in Concord, N. H. The large building just at the left of the centre is used for the tanning of the hides and the currying of the leather. Attached to this and in the rear of the chimney is the engine and boiler house. Just at the right of the chimney is a small apartment which is fitted up with iron and wood-working machinery and tools, for the purpose of making such repairs as occur in all manufacturing establishments. A little farther to the right is the counting-room; adjacent to which is the "Belt Factory." In the upper portion of this building the stretching is done, while the first story is used for the making of the leather into belting. Tenement and boarding houses are seen on either side. The small building in the foreground covers one of the two hydrants owned by the company, and contains apparatus for extinguishing fires. Two railroads starting from a union depot a mile distant, pass one on either side of the company's grounds, the one on the right running through central New Hampshire into Vermont, and that on the left passing north through the mountainous portions of the state into Canada. The sheet of water in the foreground is a bayou formed by the river Merrimack, whose course is hidden from view just beyond the railroad. On the extreme right is the city of Concord.

In this manufactory, all the operations being carried on in the buildings, every part of the business is prosecuted with equal ease summer and winter.

In making a survey of the important features of the whole process, we enter first an apartment where the heavy green hides purchased exclusively for belting are stored in large piles. We find some packed in salt; others have been through the salting operation, and, in a cured condition, await their turn to enter upon the first process of the manufacture. Here, too, the hides are carefully sorted, to avoid, as far as possible, the introduction of any hides not suitable for the business. This storage apartment is alongside of, and opens directly into, the "Beam House," in which department the hides are prepared for the tan liquors.

While in general the work done is the same as described in the process connected with the "Old Fashioned Tannery," the manner of doing the work is very different. As only hides supposed to be suitable for belting are worked, the whole process is conducted with special reference to this kind of leather. Perfect system and exact uniformity are secured. The most scientific principles, and the latest improved machinery, are employed, whereby certain work can be done much better than by hand labor, and a large reduction of cost secured.

The hides having been soaked in vats occupying the right foreground, the flesh left by the butcher on the hide is removed, as shown by the workmen on the right. The hides are then put into vats filled with a weak solution of lime. From these weak limes, on the extreme right, the hides are advanced at regular intervals into increasingly stronger limes. This transfer is shown where two men are engaged in turning them by reel out from one vat into the next, the hides being attached one to another, forming a sort of belt. When they have passed through the entire row of lime vats, they are taken from the last and strongest, which is at the left hand of the space occupied by the limes, and thrown over the beams seen in the centre of the room. The hair is then removed. After being "unhaired" they are carefully sorted, in order that any green hides supposed to be fit, but which the process proves to be unfit for belting, may here be rejected; and so only belting hides pass into the tanning liquors. After this, various millings and soakings take place for the purpose of preparing the hide for the removal of the lime, which is finally done by machinery on the extreme left. The hides are then removed to the tanning department.

The Tanning. Somewhat independent of this department and in other rooms, the bark is steeped or leached; and the liquors are prepared for use and stored in large

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WILLIAM H. WAHL, PH. D., ROBERT GRIMSHAW, PH. D., } EDITORS AND PROPRIETORS.

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reservoirs, where they are cooled and mixed to any required strength. Each stage of the process requires a different degree of strength, but one that shall be uniform for all in that particular condition. From the tanks before mentioned the liquors flow into the head vats of each section, as shown in the farther side of the room. The vats are arranged so as to permit the liquor to flow slowly down the sections to the foot pits shown in the foreground, where the green hides are placed on coming from the "Beam House." At regular intervals the hides are advanced or carried along the section until they finally pass through and leave the "head" vat. Consequently these eight vats in each section are filled with leather in as many different conditions in the process of tanning, and also with liquor of as many different degrees of strength. From the "foot" vat the liquor from which all tanning has been extracted, passes to a large underground tank, where by machinery it is pumped off for another use. This is a part of the process. The partially tanned hides, now, in another form go in to various liquors where a similar uniform and systematic course is pursued. As nearly all the work is done by machinery, only a few men are required for a large business. At the same time the best possible results are obtained. The old principles where correct are not ignored. But whatever experience and science have demonstrated to be real improvements, have been adopted.

Nothing illustrates the progress made in the business better than the modern bark mill. Among its advantages are the evenness of the ground bark and the speed with which the work is done, one man easily grinding three cords per hour in the mill here represented. No more handling of the bark takes place, as it is conveyed by machinery into the leaches. The power in this establishment is supplied through a large engine, by steam made in several boilers, by which, also, steam is made for warming the buildings, and for various other purposes in the manufacture, such as steeping the ground bark, etc. The bark, after the tanning properties have been leached out, becomes the fuel for making steam.

Currying. The first process is of the same nature as in the old fashioned curry-shop, but here, the two men toiling hard and long at the table, give place to a powerful machine tended by one man. By this machine the work is done with great rapidity, and in a manner far superior to the old method.

After the leather has been stuffed, or greased, it is put into the dry-rooms especially fitted for the purpose. At the proper time it is "set" by the scouring machine, after which the drying process is completed, and the leather is packed in large piles, to secure a certain desirable condition. When this condition is obtained, the leather is stretched.

By this machine the moistened leather is subjected to a uniform and powerful strain. When the proper strain has been secured and the leather fastened so that it will not give back, that which appears to be the top of the machine is removed to a dry-room, and another set of clamps placed on the machine for like filling. So the process is rapidly repeated until a large number of these clamps or stretchers are stored in suitable dry-rooms, where they remain until the leather is perfectly dry. Then, when taken from the clamps, the leather completely retains its stretched condition.

The last process before entering the "Belt Shop" is the finishing, or polishing the surface; as shown in Fig. 12.

(*To be continued.*)

SYSTEM.—Governor Tilden is said to have a book containing the name of every voter in New York state, with notes concerning each one—"Republican," Democrat," "Doubtful Rep.," "Doubtful Dem.," &c. This journal has similar index books, with names of thousands of manufacturers and dealers in every line of business, who are approached directly or indirectly for subscriptions, etc. Remittances are promptly noted, and promises vigorously followed up. Advertisers will see the advantage of addressing buyers through our columns.

ESTABLISHMENT IN PARIS OF A PERMANENT EXHIBITION OF RAW PRODUCE AND MATERIALS,

FOR THE PURPOSE OF FACILITATING BUSINESS AND COMMERCIAL RESEARCHES.

Statement of the Scheme Proposed by the Paris Society of Commercial Geography.—It is often very difficult for French merchants, traders and manufacturers to find the opportunity of seeing and examining certain kinds of *raw produce and materials* coming from abroad, especially when they originate in countries where European trade is but little known.

A French or European trader or manufacturer may be individually enabled, often *merely by chance*, to obtain specimens of certain foreign goods; but others, deprived of the same advantages, are ignorant even of the name of the country from which these goods proceed, and as a matter of course remain totally unaquainted with quality and quantity of production, prices, etc., etc.

Often it is not even known who is the special holder of certain kinds of produce; and thus, althoug desirous of knowing and examining them, merchants and manufacturers are totally unable to obtain them.

Hence arise numberless delays; manufacturers have to grope their way in the dark, and their efforts and researches are often completely paralysed.

In order to fill up this gap in our commercial institutions, and to facilitate the investigations to which we refer, the *Paris Society of Commercial Geography* has decided on founding at Paris a permanent exhibition, where complete samples of foreign raw produce, either *vegetable*, *mineral* or *animal*, will be *gradually* collected. It is also destined to obtain specimens of coins, postage stamps, bank notes, telegraphic apparatus, bills of exchange, etc.

To each sample or specimen will be joined a short notice mentioning country of production, actual price, quantity available yearly, means of acquisition, cost of production, purchase and conveyance to Europe; finally the best means of effecting the purchase, viz. either in *cash* or by giving European *goods* in exchange.

Men of business will not fail to understand the importance of an exhibition of this kind, where the merchant or manufacturer will be sure to find both the samples he may wish to examine, and the information requsite to throw light in every respect on the purchases he may intend to make.

With the same view to general commercial interests, and through the intermediary of the Paris Society of Commercial Geography, the Exhibition would receive specimens of raw produce already known, but not sufficiently so, whenever proprietors might wish to lay them before the public.

For this purpose Dr. Saffray, the delegate of the society to the Universal Exhibition of Philadelphia, has received instructions to request Exhibitors officially in the name of the Society of Commercial Geography, to join in the work, and forward any specimen they may wish to exhibit.

Every article thus forwarded will be entered into the books of the Permanent Exhibition, and will appear bearing the name and address of the exhibitor, together with notice accompanying each sample.

All specimens forwarded by Philadelphia exhibitors, on the official request of Dr. Saffray, the delegate of the Paris Society of Commercial Geography, must be put on the steamer at the risk and charge of the owners, who will also have to bear the cost of conveyance to France on the Transatlantic Company's steamers.

We may also state here that if an official request were addressed by the Paris Society of Commercial Geography to the Board of the "*Compagnie Générale Transatlantique*," they would certainly reduce considerably the carriage of goods sent over as gifts to the Permanent Exhibition by Philadelphia exhibitors.

*Le Secrétaire Général, Directeur du Journal l'*Explorateur, *membre du Conseil de la Société de Géographie de Paris.*—CH. HERTZ.

Le Président, Directeur des consulats et des affaires commerciales au ministère des Affaires étrangères de France, Président de la Société de Géographie de Paris.—MEURAND.

Les délégués de la Commission, FELIX SICARD, *capitaine au long cours.* LUCIEN DE PUYDT, *ingénieur civil.*

WE shall shortly publish some articles upon "THE STEAM ENGINE SLIDE VALVE," carefully prepared by MR. JOSHUA ROSE.

The reader of these papers will obtain a clear and accurate knowledge of the action of slide valves without having either to make a single calculation or to draw a line; while at the same time the general action and effect of an existing valve or a proposed alteration in one, may be at once understood without making the subject a special study.

At the same time we shall publish a popular and practical exposition of the INDICATOR DIAGRAM, by the same author.

SAFE OIL IN THE HOUSEHOLD LAMP.

II.

It is simply to be set down to good fortune, if one who has employed the light oils for household purposes has escaped injury, since no amount of care can avail against the inevitable result which must follow one accident. It is easy to understand how persons ignorant of the highly dangerous character of the light petroleums may unknowingly make use of them in the manner above named; but it is really a matter of concern and surprise that so many, even of those who are thoroughly aware of the nature of the incendiary they are introducing into their households, are nevertheless, thoughtless or indifferent enough to continue the suicidal practice—for no term can be too strong to properly characterize the fearful nature of the risk one is constantly running while employing these oils in the household.

There seems to exist a notion that the explosive or inflammable properties of the light petroleums can be effectually neutralized by adding various substances to them. The Patent Office records for the past few years contain numbers of claims for such mixtures of naphtha or gasolene with a great variety of substances, too numerous to mention.

Whether or not the inventors of these recipes really have faith in the claims they present, is a matter of small importance; but the deceptive illustrations which they are able to offer in vindication of their assertions, no less than the attractive names which they attach to their incendiary mixtures, are the sources of many distressing calamities.

There is one simple and, for practical purposes, satisfactory method of determining the character of all such mixtures, and which applies equally as well to the common oils. Let a few drops be poured into a saucer, apply a match; if the material burns, reject it as unsafe. The fact that the material can be set on fire at the ordinary temperature of our dwellings should be a sufficient evidence to a person of ordinary intelli-

gence that, when employed in the household, it may, at the first thoughtless or careless act, become the cause of a frightful accident.

Now, for the reason why these dangerous oils find their way into the market, in defiance of legal prohibition.

The crude petroleum, as it comes from the wells, is not a simple substance, but consists of a mixture of a number of oils. The operation of refining the crude product consists essentially in subjecting it to a system of frictional distillation, whereby it is separated into some six or seven products, to which the commercial names of rhigolene, gasoline, naphtha, benzine, kerosene, etc., are attached.

The benzine or naphtha makes up generally about 15 to 20 per cent. of the crude oil, and for this demand in the various industrial arts is by no means equal to the supply; in consequence of which it commands but an inferior price in the market: in fact, considerably less than that demanded for the burning oils proper. Here, then, exists a direct temptation to dishonest or ignorant manufacturers and dealers to adulterate their stock of burning oil with oils of inferior price and dangerous quality. To what extent this reckless practice is carried on, the community have no just conception, but the writer feels safe in asserting that it is as general as any of the trade adulterations.

So general has it been practiced, in Philadelphia at least, that only three years ago an examination of three thousand oil samples sold in the various parts of the city and its suburbs, showed that not more than $\frac{1}{12}$ of 1 per cent. of all the burning oils sold in the shops of this city, were of sufficiently high grade to pass the fire test; and it may be added, that there is no reason to suppose that any improvement of this condition of things has taken place since the time when that examination was made. The constant occurrence, therefore, of accidents with coal oil—so long as the cheap and highly dangerous products of the refinery are indiscriminately used to adulterate the comparatively safe burning oil, the kerosene, or doctored, with equal impunity into the numberless burning mixtures with alluring names that meet one at every turn—is a perfectly natural result, and one that should occasion no surprise. And so long as inspection is a farce, and the inspector and vendor are beyond the pale of legal accountability for their deeds of omission and commission, just so long will coal oil murders and disasters continue to be deplored.

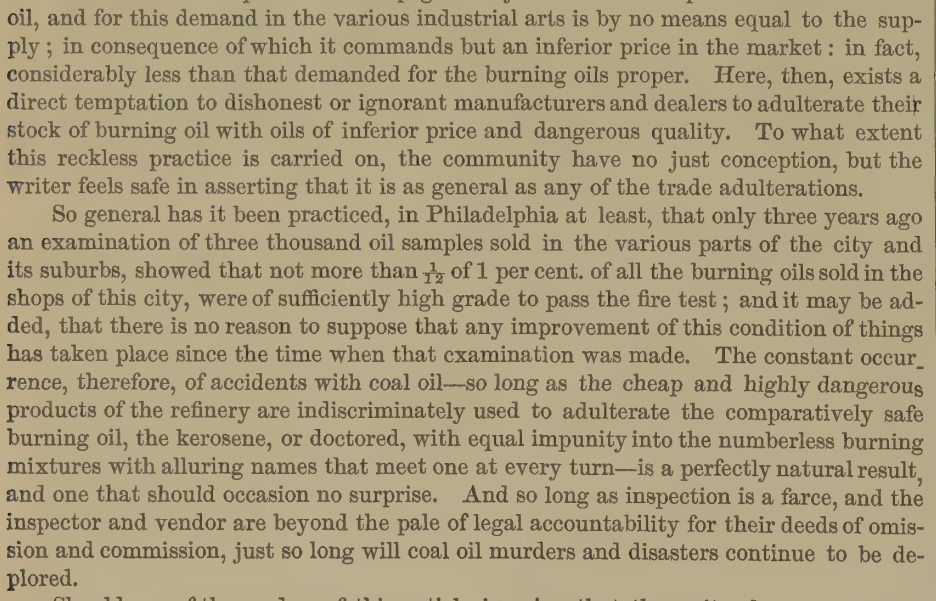
Should any of the readers of this article imagine that the writer has exaggerated the extent to which the illegal adulteration of kerosene is carried, let him call for a sample on sale at the nearest grocer's, and try the experiment of igniting it with a match, the simple and excellent test of safety before alluded to. The probabilities are that the experimenter will find a good part of the day spent before the experiment has been successfully made.

So crude indeed are the notions that are entertained of the nature of safe oils by ignorant vendors, that our experimenter will more likely than not, be laughed at, and informed that an oil that will not ignite from a match will not burn in a lamp. Finally, it may be added, for the benefit of those who do not wish to assume the responsibility of doing their own inspecting, that they are not left completely at the mercy of the vendor, inasmuch as certain manufacturers, fully appreciating the situation, have gone extensively into the business of producing burning oils of superior quality, and send them to market as unusually safe oils.

It is greatly to be regretted, that in this field of manufacture, a few firms stand alone, and that, while foreign countries which receive vast supplies of American petroleum, carefully and rigorously exclude all oils that do not come up to the standard fire test, by a simple inspective system at the ports of entry, made by competent officers—in this country, adulterated burning oils are sold indiscriminately and universally, with the most criminal disregard of the safety of life and property, in open defiance of the law, or, in many situations, it is to be feared, with the secret connivance of those whose duty it is to see that the law is executed. W.

THE OTIS BROTHERS & CO. MOWING MACHINE.

In examining the machines in Agricultural Hall, the attention will be forcibly attracted by a very curious and most ingenious mechanism for moving the knife of the "Haymaker" exhibited by Messrs. Otis Brothers & Co., New York (see the cut). For the train of gear wheels, transmitting the rapid reciprocating motion to the knife,



from the slow rotating motion of the driving wheels, as seen in most of the exhibited mowing machines, a single pair of bevel wheels of internal gearing, acting as a differential gear, are substituted.

The smaller mitre wheel A, having 46 teeth, is fastened to the axle of the driving wheels, and will therefore rotate in the direction of the arrow when the mower is in operation. The larger mitre wheel, B, having 48 teeth, together with the angular bracket C, is attached to the body of the mower by a universal joint, the centre of which coincides with the apex of the rolling cones of the mitre wheels. This joint prevents the wheel from rotating on its axis, but permits an oscillating or gyrating motion. The end, *b*, of the bracket, C, is jointed eccentrically to a small fly-wheel, D, having the form of a taper plug which, revolving freely on its axis, guides it in a circle. Should the end *b* be moved to the centre of this circle both mitre wheels would assume a central position and come out of gear; but being guided as above stated, the wheels will constantly remain in proper gearing. When in operation, the wheel, B, while in the position shown in the top view of the mechanism, will be pressed downwards by those teeth that are in full gear, and a rotation being made impossible by the universal joint, it will work on its fulcrum, *a*, raising the end, *b*. In consequence of the rising of this point, however, the position of the wheel, B, will be changed, and the upper teeth coming in gear, the end, *b*, of the bracket will now be forced in a direction indicated by an arrow. This movement causes a further retrogression of the point of contact of the bevel wheels, and hence the fly-wheel, D, will be rotated in a direction opposing that of the bevel wheel, A. Owing to this rotation, the angle-bracket, C, will receive a reciprocating motion that is directly transmitted to the knife from the end, *c*. Now, as the wheel B possesses two teeth more than the wheel A, the fly-wheel will complete a whole revolution while the wheel A advances just two teeth, or 23 revolutions for every revolution of the driving wheels.

The loss of power by the friction of the mechanism is indeed very small, as is attested by a pair of such mitre wheels having been in use for five seasons and showing hardly any wear.

Without leaving his seat, the driver can raise the cutter-bar bodily or set it any angle, to adapt it to the most varying conditions, and can throw it in or out of gear at pleasure; or he can fold it and secure it for leaving the field; in short, he has a perfect control over the machine through levers worked either by hand or by foot.

By reason of its light draft, and simplicity of construction, this mower has a fair chance of becoming a favorite among the farmers. HUGO BILGRAM.

OUR SPECIAL NUMBER, containing Prof. Thurston's article on LUBRICANTS, and short articles from nearly all of our regular contributors, will have an unusually large circulation and increased advertising custom.

TURBINE WHEELS AT THE CENTENNIAL EXHIBITION.

III.

THE ECLIPSE DOUBLE TURBINE.

[Manufactured by the Stillwell & Bierce Manufacturing Company of Dayton, O.]

This turbine is distinguished for having two wheels in one, both of a size, and nearly similar in form, one above the other, as shown in section in Fig. 1. The curved floats are placed alternately, which serves to relieve the wheel from shocks due to con-

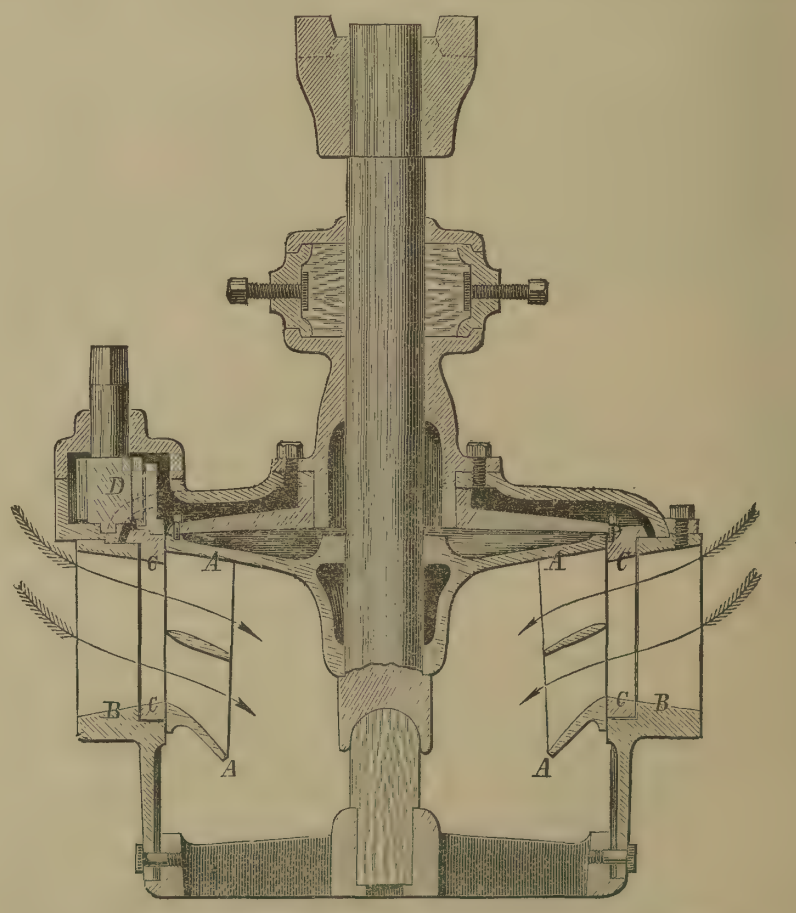


FIG. 1.—VERTICAL SECTION OF THE ECLIPSE DOUBLE TURBINE.

tingence of buckets with the affluent water jets. The water ways in the wheel are flaring toward the center and downward, thus compensating, in a measure, for the usual contraction of the same, as shown in horizontal sections. This form favors a uniform velocity of the water along the float surfaces, which is one condition needful for the best effect. The builders hold that the advantages gained by introducing this partition in the wheel, more than compensate the loss due to the friction of the water against the two sides of it.

The gate is formed, as it were, by cutting the guides all into two concentric parts,

B and C, Fig. 2, the outer being stationary, connecting the upper and lower parts of the case, while the inside parts are suspended on a spider which is supported by, and freely revolves around, a central bearing. In this way the two parts of the case may be given a sort of shearing action, closing the chutes to any desired extent. At full gate this gives an almost faultless form of guide opening; though the direction is nearly

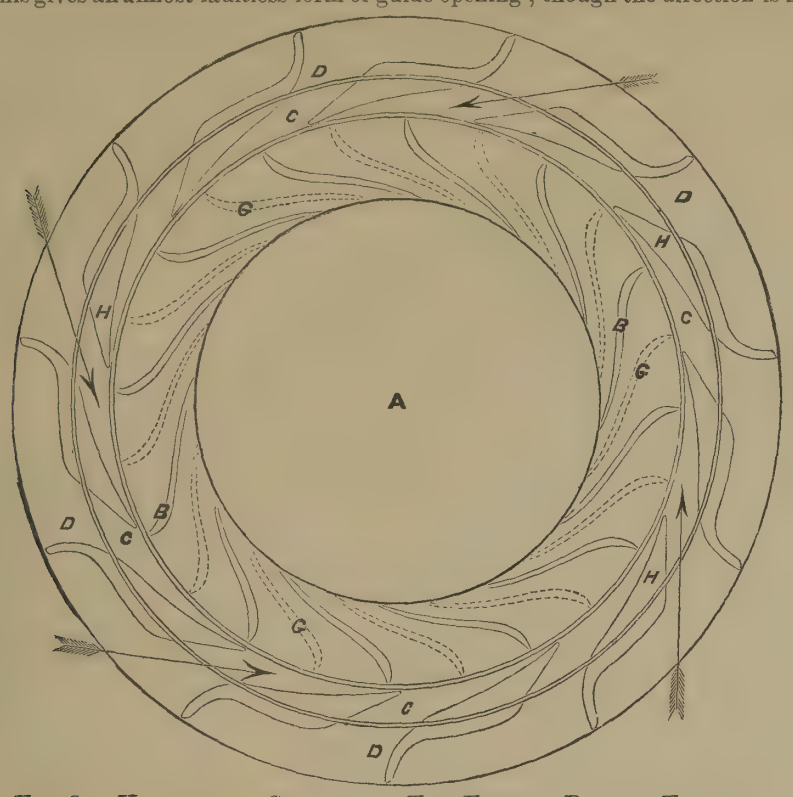


FIG. 2.—HORIZONTAL SECTION OF THE ECLIPSE DOUBLE TURBINE.

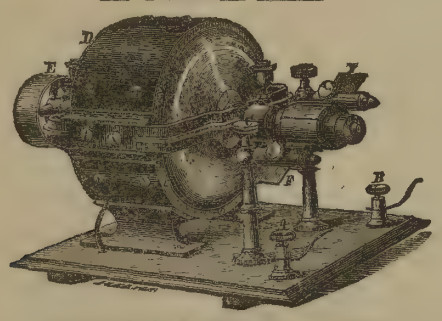
tangential to the wheel, with an apparent effort to get it quite so, which is hardly consistent with theory for the present form of curve of wheel float. At partial gate openings, the water is throttled between B and C, with the effect of an enlargement in the chute between there and the wheel. The water, however, will still be projected through the contracted opening with a high velocity, nearly as through an orifice in a thin partition, which gives the highest known velocity of projection; and if it can be shown that the enlargement of chute, between the contraction and the wheel, has no retarding action upon the stream, the wheel should give good part-gate results.

This turbine has the advantage of great simplicity of construction; the wheel being entirely in one piece; the gate and suspending spider each one; and the outside case in two pieces. All the parts are very carefully made to gauges, so that duplicates, furnished in case of accident, will fit with certainty.

The gate is subject only to horizontal pressure, exactly balanced at opposite sides, so that the gate moves with great freedom. This, together with the small movement required to fully open it, indicates easy control by a governor. All moving parts of the gate are protected, under covers, from danger of interruption by floating rubbish; and this wheel appears to be one of the few in which the opening and closing rack and pinion are thus cared for.

S. W. ROBINSON.

School of Mechanical Engineering, Illinois Industrial University.



ELECTRO-PLATING BY STEAM.

Galvano-Plastics, or the art of electro-plating, which stood still for years with the supposition that it was already perfected, has recently made astonishing advances, which, though marked and radical, are no more so than the importance of the subject merits.

Formerly galvanic batteries were employed for exciting the electric current, the excitation being effected by the reduction of metallic zinc to solution with acidulated water. This destruction of zinc was, by a happy experiment, found to be sufficient to take other metals from their solutions and to build them up in the solid form. The apparently mutual relation of these transformations probably stood in the way, somewhat, of the valuable improvements now under consideration. At all events the present state of the art shows that the source of the electricity is of no consequence whatever, provided it has the proper qualities, viz., a large quantity with comparatively low tension.

In Machinery Hall, B. 10, column 78, Centennial Exposition, was seen in operation, the *Weston Dynamo-Electric Machine* as employed for nickel plating. The machine is run by a belt driven by steam, though any motor applies. The apparatus transmutes the power into electicity, and the current is employed in the plating bath in the usual way.

In the cut, E is the pulley for receiving the belt as above mentioned. The shaft upon which E is mounted lies in the axis of the cylinder-shaped covering D, supported by journal bearings at the ends. At the extreme end opposite E, is fixed upon the shaft a series of segmental pieces, insulated from each other, and the whole turned off to cylindrical form. Against these segments rub the "contact makers" F F. These with the compound cylinder upon which they rub, constitute the commutator.

The arrangement of magnets and coils, concerned in exciting the current, is contained inside the case D, where they are well protected from dust and accident. The binding screws A and B are for attaching the conducting wires, transmitting the current to the plating bath, or other point.

The machine is very compact and simple, as indeed the cut shows, and is of elegant design und finish. During the several weeks that it has been in almost constant action in Machinery Hall, it has required no other attention than putting on the belt and attaching the wires.

The apparatus possesses remarkable electrical power for one of its dimensions and weight. One machine which would go in a box about a foot square, will heat a wire nearly as thick and long as a knitting needle, to the fusing point. A larger machine exhibited has a correspondingly higher power, as trials have shown.

The great advantages of these machines over the old fashioned batteries cannot be over-estimated. Whereas the latter are inconstant in action, need momentary attention, are perpetually requiring fresh chemicals to convert into objectionable fumes, residues and dirt; the former are neat, always ready, giving a constant current, and requiring no chemicals.

A machine costing $160 is sufficient for operating a plating bath of 200 gallons, and may be run by a water motor attached to the water supply. Further information may be obtained of Condit, Hanson & Van Winkle, 236 Market Street, Newark, New Jersey.

S. W. R.

FLUOR SPAR AND ITS USES.

COMPOSITION AND PROPERTIES.—Fluor Spar derives its name from the Latin *fluo* to flow, on account of its extensive use as a flux. It is the fluoride of calcium, and consists of 48.7 per cent. of fluorine and 51.0 p. c. of calcium. It may be distinguished by its giving off a phosphorescent light when heated to a point below redness. The test is readily applied by sprinkling the powdered spar upon a hot shovel in a dark room. It frequently forms the vein stone of valuable ores, as in southern Illinois, where it occurs finely crystallized and of great purity, along with galena. It is sometimes colorless, more frequently of various tints of blue, green, red, yellow and purple; the more beautifully colored and compact varieties are turned into vases and other ornaments, under the name of Derbyshire Spar.

USES.—The manifold uses to which fluor spar is applied may be classed under two heads:—

1st. Of the mineral in its native condition or coarsely or finely powdered.

2d. Of the various compounds and products obtained from fluor spar by union with other substances, or by the action of chemical agents. Under the first class, are its use as a flux in the metallurgy of iron, copper, and other metals, as a flux and beneficial ingredient in the manufacture of glass, etc.

Under the second class are its compounds with silicon, hydrogen, boron, potassium, sodium, aluminum, and many other elements which have found extensive employment in the arts, such as hydrofluoric acid, hydrofluosilicic acid, fluoride of silicon, the silico-fluorides of potassium and sodium, and the compounds of the alkaline fluorides, and of hydrofluoric acid, with the fluorides of other metals.

FLUOR SPAR AS A FLUX.—In copper smelting, the copper ores are frequently associated with a large quantity of *gangue*, or mineral substances, which must be gotten rid of; this is effected by the addition of fluor spar. The fluor spar, when strongly heated in contact with silica, is decomposed, fluoride of silicon escaping, and the calcium uniting with another portion of silica, to form silicate of calcium. This is not fusible enough to form a proper slag, but along with the clay and oxide of iron present at the same time, produces a readily fusible slag; the amount of fluor spar is regulated by the experience of the smelter to meet these requirements. Similar remarks apply to the melting of antimonial and other ores.

In the manufacture of *steel* and wrought iron by the fluorine process of Mr. Jas. Henderson: This is effected by treating the iron, as it flows from the blast furnace, with fluor spar and iron ore. A mixture of one part of finely-ground fluor spar and two parts of iron ore is spread to a thickness of about $\frac{3}{8}$ inch on the bottom of the pig moulds. The heat decomposes the mixture and the fluorine and oxygen are set at liberty to act upon the silicon and phosphorus in their passage upwards through the melted iron. It is claimed that the Henderson refined metal, in respect of silicon and phosphorus, is as pure as wrought iron.

Another method employed by Mr. Henderson is that of charging granulated cast-iron into a furnace in admixture with titaniferous iron ore and fluor spar, both in a pulverized condition. This method has been still further modified in connection with a furnace designed by Mr. Henderson with the object of meeting the especial requirements of his process. The heat is supplied by the combustion of carbonic oxide produced in a gas generator, and burned at the mouth of a blow pipe supplied with the proper amount of air under pressure; the furnace has a movable hearth worked by a hydraulic lift. While the hearth is out of the furnace the minerals of the process are charged upon it, except when pig-iron containing over 0.50 p. c. of phosphorus is used; in this case the lining is covered with thin sheet iron, and upon this a mixture of titaniferous iron ore and fluor spar is placed. The hearth is then put into place, the blast applied, and in about three minutes the minerals become solid enough to support the cast iron, which is run in upon them from a cupola. It is claimed that a good wrought iron and steel can be produced from pig iron unfit for this purpose in other processes; that there is economy in fuel, labor, and capital; that the product is superior owing to the elimination of impurities, and that cast-steel and homogeneous wrought iron may be produced at lower cost.

FLUOR SPAR IN GLASS MANUFACTURE.—It has been used in small quantities for this purpose, and is claimed by American manufacturers to render the glass more fusible and thus save fuel, and by European makers to increase the strength of the glass as well.

[Report by Prof. A. R. Leeds.]

(To be continued.)

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c

Railroads of the World in 1876.—The *Moniteur Industriel Belge* gives the following approximation :—

I—EUROPE.

Western Europe.

	Kilometres.
British Isles,	26,318
France,	22,837
	49,155

Central Europe.

Belgium,	3,370
Holland,	1,688
Switzerland,	1,638
Germany,	27,956
	34,632

Northern Europe.

Denmark,	897
Sweden,	3,640
Norway,	426
Russia,	19,431
	24,934

Eastern Europe.

Austria,	9,823
Hungary,	6,415
Roumania,	826
Turkey,	1,046
	18,110

Southern Europe.

Greece,	11
Italy,	7,521
Spain,	5,347
Portugal,	848
	43,727
Total for Europe,	140,558

II—ASIA.*

Asiatic Turkey,	329
Caucasus,	300
British Indies,	10,092
Ceylon,	82
Java,	267
Japan,	27
	11,102

III—OCEANICA.

	Kilometres.
Australia,	2,246
New Zealand	243
	2,489

IV—AFRICA.

Egypt.	1,782
Algeria,	513
Cape,	105
Natal,	3
Mauritius,	106
	2,405

V—NORTH AND CENTRAL AMERICA.

United States,	128,880
Canada,	6,440
Mexico,	536
Cuba,	537
Jamaica,	43
Costa Rica,	67
Honduras,	84
	136,687

VI—SOUTH AMERICA.

Colombia,	80
Bolivia,	45
Venezuela,	13
Brazil,	1,265
Paraguay,	70
Uraguay,	576
Argentine Con.,	2,200
Chili,	1,212
Peru,	1,600
	6,841

RECAPITULATION.

Europe,	140,558
Asia,	41,102
Oceanica,	3,489
Africa,	2,409
America,	143,528
Total for the entire world.	301,086

Her Majesty's Ship Dreadnought. — The new twin-screw double-turret ship Dreadnought, built at Pembroke, arrived at Portsmouth on Monday morning for the purpose of having her hydraulic gun-gear fitted and to be generally completed for sea. She left Pembroke at about half-past three on Saturday afternoon, and had good weather all the way until near her destination, when she encountered a heavy wind, which put her seaworthiness to a test with very gratifying results. Though escorted by the Valorous, Captain Jones, she made the voyage entirely by means of her own machinery, which is by Messrs. Humphreys & Tennant, and was found to work in a very satisfactory manner. The engines are constructed on the inverted direct-acting plan, each having three cylinders, the high pressures having a diameter of 60 in., and the low pressures a diameter of 90 in. The stroke is 4 ft. 6in. The tube plates of the boilers are ¾ in. thick, the shells being of the same thickness, and the back plates ½ in. The contract price of the engines is £70,000, while the boilers will cost over £30,000 more. During Sunday the engines were tested with a pressure of 30 lbs. to the square inch, or one-half the full pressure at which the boilers are intended to be worked. A maximum of 54 revolutions was obtained, the horse-power developed being 4,900, or considerable over one-half the contract power. The greatest speed realized was close upon 13 knots. A splendid vacuum was reached, the gauges indicating 28 lb. and 29 lb. in the condensers. This vessel was originally named the Fury. [*The Engineer*, xii, 252.]

New Steam Excavator.—Messrs. Alex. Chaplin and Co., of the Cranstonhill Engine Works, Glasgow, have just constructed a very powerful "steam navvy" or excavator, which they have been exhibiting under steam in their premises during the past week. The frame is entirely of malleable iron, with angle irons welded at the corners, plated with nine-sixteenth plates, and weighs 4½ tons. Underneath the frame are two steel axles, each having four wheels, the outside ones double flanged, for the purpose of working the machine, and the inside ones single flanged, so as to go on a 4ft. 8½ in. railway gauge. The front part of the machine is supplemented by two wings, one on either side, having screws so as to give lateral stability to the machine, when the digger is required to work at right angles to it. The motive power consists of a pair of 8 in. cylinders of the inverted type, with pinions and crank shaft, working into a larger wheel in the barrel, which is grooved to receive the chain. Near the front of the machine is a very strong cast-iron column, round which the jib, which is of malleable iron, is made to revolve for one-half of a circle. Two men are required to work the machine, one having entire charge of the engine for hoisting and slewing, and the other man, who stands upon a little platform, regulates the out and in motions of the digger. This latter, by the use of a friction clutch and friction brake, has the entire control of pushing the digger out and in to the material to be excavated. Simultaneously with the hoisting or shoving out action, the bucket or spoon is drawn by pitch chain wheels, and it scrapes up the face of the bank, taking a cubic yard of material at every lift. Alongside the machine there must be accommodation rails for the wagons to come and receive the soil; and as soon as the bucket is filled, it is slewed round by the attendant at the engine, either to the one side or to the other, right over the empty wagons, and a trigger being drawn, the contents of the bucket fall into the wagon. While the bucket is returning to the working place, it shuts automatically at the bottom, and so is prepared to rake up another fill. The frame is long, broad, and remarkably stable, and by having placed on one end of it the boiler and engines, and at the other the gib, gear and bucket, the whole machine presents the appearance of being admirably balanced, and certain to sit like a rock with an immense strain upon it. The machine is of such a size that it will carry a cutting down to a depth of twenty feet while it is stationed in one level, and it is calculated that by its use the labor of eighty men will be superseded. The one exhibited last week has been built for a limestone quarry near Edinburgh, where it will be employed in tirring off the strata overlying the limestone. [*The Engineer*, xlii, 252.]

Steam on the Canals.—Says the Springfield, Mass., *Republican*: It is rather remarkable that the prize of $100,000 offered by the State of New York, for the application of steam to canals, has utterly failed to bring out a practicable device, while the Belgian cable towing-system, which was specially excluded from competition for the prize, is in successful operation on the canal. The State awarded $50,000 to the Baxter system, but the company which undertook to introduce that system has become bankrupt, and its effects have been sold under the hammer. The failure was inevitable, from the fact that it costs more to apply the system to a canal barge than it would to build a new boat, thus doubling the first cost of the craft. On the other hand, the Belgian cable towing system has been in successful operation between Middleport and Buffalo, forty-two miles, for several weeks. Since the middle of June, two towboats have towed 250 barges with their cargoes, averaging 200 tons of coal each, against a strong current, without injury to the canal and with satisfaction to the boatmen. On the 9th of July, seven boats, with 1500 tons of coal, were towed against a three mile current from Tonawanda to Buffalo at three times the speed of double the usual animal power. One boat consumes a ton of coal in 24 hours, and can be operated at an expense of $25 for that time. The charge to boatmen is the same as for horse-power, but the speed is two or three times as great. Altogether, we do not see why this system does not achieve all that can be asked for in the application of steam to canals. [*The Engineer*, Oct. 13, 1876.]

[*The Woosung R.R. of China is omitted. EDS.]

MINING, METALLURGY AND MINERALOGY

Missouri Lead Yield for 1876.—The total receipts of lead from the mines and furnaces of Missouri will exceed 18,000 tons. [*Mines, Metals & Arts*, v, 260.]

The New Nomenclature of Iron and Steel.—Below is the report of the International Committee appointed by the American Institute of Mining Engineers on the Nomenclature of Iron and Steel:

Whereas: The recent production of soft, cast malleable compounds of iron by the Bessemer, the Siemens-Martin, and the crucible steel processes appears to demand a new nomenclature of iron compounds, for the following reasons:

1st. The term "steel," by which these soft products are commercially and professianally designated in England, and in the United States, does not completely distinguish them from previously existing "steel" which would harden and temper.

2d. A nomenclature recognized in all languages seems desirable, as well for commercial as for scientific purposes, especially as law-suits, already commenced, depend on the meaning of the term "steel."

3d. Although homogeneity, due to fusion, is usually recognized and is, by this committee, recognized as the most definite characteristic of both hard and soft steel, this quality may be equally well expressed in other terms, thus leaving the old term, "steel," to define the malleable compounds of iron, which will harden and temper:

Therefore, resolved, That this committee reccommends the following nomenclature:

I. That all malleable compounds of iron with its ordinary ingredients, which are aggregated from pasty masses, or from piles, or from any forms of iron not in a fluid state, and which will not sensibly harden and temper, and which generally resemble what is called "wrought iron," shall be called weld iron (German, *Schweisseisen;* French, *fer soude*).

II. That such compounds, when they will from any cause harden and temper, and which resemble what is now called "puddled steel," shall be called weld steel (German, *Schweiss stahl;* French, *acier-soude*).

III. That all compounds of iron with its ordinary ingredients, which have been cast from a fluid state into malleable masses, and which will not sensibly harden by being quenched in water, while at a red heat, shall be called ingot iron (German, *Flusseisen;* French, *fer fondu*).

IV. That all such compounds, when they will from any cause so harden, shall be called ingot steel (German, *Fluss stahl;* French, *acier fondu*).

(Signed,)

I. Lowthian Bell. Dr. Hermann Wedding,
P. Turner, Richard Akerman,
A. L. Holley, Thomas Egleston,
L. Gruner.

[*Engineering and Mining Journal.*]

Nickel Mines in Spain.—Mons. Meissonier, Inspector General of mines in France, has reported to the Academy of Sciences, the existence in Spain of a deposit of nickel. This deposit is situated in the province of Malaga. It has already yielded several hundred tons of ores. These, submitted to analysis at the *Ecole des Mines*, have been recognized as similar to those of New Caledonia. They contain 8 to 10 per cent. of pure metal;—perhaps a little less than those of New Caledonia. No trace of cobalt has been discovered. [*Moniteur Ind. Belge*, iii, 493.]

The *or-moulu* of the brass founder, popularly known as an imitation of red gold, is extensively used by the French workmen in metals. It is generally found in combination with grate and stove work. It is composed of a greater portion of copper and less of zinc than ordinary brass, is cleaned readily by means of acid and is burnished easily. To give this material the rich appearance, it is not unfrequently brightened up after dipping, by means of a scratch brush, the action of which helps to produce a very brilliant gold-like surface. It is protected from tarnish by the application of lacquer. [*West. Manuf.* iii. 282.]

CHEMISTRY, PHYSICS AND TECHNOLOGY

Artificial Coloring of Wines.—Since the vintage of 1875, the artificial coloring of wines in France has attained such a development as to raise fears not only for the good name of French wines, but also for the public health. The syndicate of wine merchants of Paris has taken the matter up and urged it upon the attention of the French government in a vigorously written memorial, in which it is roundly asserted that the sole object of the coloring is so to treat a wine, at an insignificant cost, that it may be sold considerably above its real value. Formerly coloring was only done to a small extent and with vegetable and comparatively inoffensive matters, but now it is stated, hundreds of kilograms of arsenical fuchsin and other equally poisonous substances are used for the purpose, and the sale of such preparations is openly advertised. The Syndicate urges that it is useless to discuss in chemical laboratories whether fuchsin itself, or arsenical fuchsin when diluted to a certain extent, is poisonous or not, there being no guarantee against the greediness of the wine colorer. One result of the agitation has been that the officers of *octroi* have been ordered to take samples, for analysis, of all red wines coming into Paris. [*Phar. Jour. and Trans.*, Sept. 23.]

Soap Root.—A large commerce is carried on from California in a fibrous substance known as soap-root. It is obtained from a lily-like plant, a species of Phalangium (*Chlorogalum pomeridianum*, Kunth), which is met with about the mountains, and attains a height of eight feet. The heavy bulb is covered with many coatings, consisting of fibres, which are used for cushions, mattresses, etc. Large contracts are entered into for the supply of this material on a very extensive scale. The inner part of the bulb serves as a substitute for soap, and it might be tried whether it can be utilized for tech-

nological purposes like the root of *saponaria*. [*Drug. Circ. and Chem. Gaz.*]

Industrial Application of the Sun's Rays.—M. A. Mouchot.—The author presents to the French Academy a small "solar alembic," easy to set up and to remove. The mirror is 50 c. m. in diameter; the boiler contains one litre of wine, which is brought to a boil by half an hour's exposure to the sun. The vapor of alcohol enters a tube placed in the centre of the boiler, traverses the foot of the mirror, and descends into the worm, where it condenses. The foot of the mirror is a gas-tap fitted with a groove and a set-screw, which permit the boiler to be always turned to the sun. If the boiler is filled with water, and if a receptacle full of leaves or odoriferous flowers is interposed between it and the worm, all the essences procurable by distillation may be obtained. [*Chem. News*, xxxiv, 183.]

Emery Grinding Stones were until now almost exclusively obtained through a mixture of gum, shellac, and emery. When they work with rapidity the shellac is softened, and the grinding stone, becoming greasy, ceases to polish. This difficulty is remedied by using, instead of shellac, soluble glass; this is done in certain German manufactories, the grinding stones of which are not corroded. They may turn at a velocity of 1,000 to 2,000 turns, without losing their form [*Revue Industrielle*, vii, 319.]

Varnish for Cane and Basket-work.—According to the "Hessischen Gewerbeblatt," lac, prepared after the following recipe, is used to cover split and colored cane:—25 grs. of good linseed oil are heated in a sand-bath, as long as a drop of it, poured on a cold stone, does not run when the stone is inclined, and when touched with the finger it feels thready. Then are added, first in small portions, one lb. fat copal varnish, or some other fat varnish. The heating of the linseed oil must not be carried too far, because otherwise it would not be completely dissolved in the copal varnish, and the vessel wherein the copal varnish is heated must be large, because by the addition of the linseed oil a great deal of frothing takes place. When cold, the required consistence is given to the varnish by mixing it with turpentine oil. It soon dries, preserves a sufficient elasticity, and may be applied with or without addition of colors. [*Stummer's Ingenieur*, July, 1876, through *Pract. Mag.*]

Professor Anthony's Electric Light Experiments.—Professor Wm. A. Anthony, of the Physical Department, Cornell University, sends the following interesting account of his recent experiment, which we briefly noticed on page 289, current volume. In that notice the lamp used for comparison of light values was incorrectly designated as the one used in the engine. Professor Anthony says:

"The following is a brief description of my experiments: To the electro-magnetic machine, which was driven by a Brayton petroleum oil engine of five horse power,* wires were connected for conveying the electricity produced to a room some 300 feet distant, from which daylight could be excluded, for photometric experiments. In this room, the wires were connected with a Foucault regulator for the electric light, the light being produced by the passage of the electric current between two carbon points. The electric light being too brilliant for direct comparison with the standard candle, I took from my house a common coal oil lamp, having a flat wick one inch wide. The electric light was found to be equal to what would have been produced by 234 such lamps. But 234 such lamps would have consumed nearly 16 lbs. oil per hour, while the engine, whose power developed the electric current, which in turn produced the electric light, consumed but $6\frac{3}{4}$ lbs. oil in the same time. This fact was stated in the paper giving the results of my experiments merely as showing, in a striking manner, how very small a proportion of the energy of combustion of the oil in the common lamp is utilized." [*Sci. Am.*, xxxv, 329.]

What Gives the Cheapest Light?—Combining some experiments made recently in London with others made here in regard to the most economical mode of illumination, we come to the results expressed below, which indicate how long various lights of equal strength will burn for an equal amount of cost; the numbers therefore give a correct idea of the comparative economy:—

Wax candles	66	minutes.
Sperm candles	67	"
Sperm oil in economical lamps	72	"
Stearin candles	87	"
Paraffin candles	135	"
Common dipped candles	172	"
Almond oil	180	"
Gas	400	"
Kerosene oil	1000	"

[*Man. & B.*, Nov. 1876.]

A new process in textile manufacture has been invented, which is applicable to the production of certain goods hitherto made by felting or weaving. The principle consists in covering a strong, cheap foundation, such as ordinary canvas or cotton sheeting, with a facing of wool, either on one or both sides, as may be desired. This is done by picking the woolen fibres into and through the foundation cloth, fixing them tightly and permanently. The machinery which has been devised is extremely simple, and does the work rapidly and efficiently. We have taken great pleasure in examining sample specimens of cloth, of various thickness, and are very favorably impressed with the invention. The superior strength and "feel" of the goods, compared with the amount of wool required in making them, cannot fail to adapt the new method most advantageously to numerous fabrics in which either a plain surface or printed patterns can be used. [*Carpet Trade*, November, 1876.]

* Illustrated and described in the POLYTECHNIC REVIEW, Feb. 10.

The Fuel of the Future.—We cull from the *Engineering and Mining Journal*, (vol. xxii, p. 293) the following remarks confirmatory of the views advanced in our article on Heating Gas, published in our issue of October 28th, viz:—

"We are convinced that the question of the economical production of a good heating gas once settled, the business of manufacturing it will greatly overshadow, by its enormous proportions, that of making illuminating gas. There is scarcely a use to which we now apply coal in our cities that would not be benefitted by the substitution of heating gas, if the price were sufficiently low. We confidently anticipate the introduction, before the lapse of many years, of heating gas for general domestic use; but though this will be attended with an enormous economy in the consumption of coal, we see nothing in it to injuriously affect the coal trade.

Experience has shown that every economy in the use of fuel has been followed by such a great and rapid development of the industries using coal, that the total consumption of this has increased instead of diminished. If but half of the coal now consumed in this city were converted into heating-gas, at some central works, and distributed, as illuminating gas now is, it would more than do the work now done by the coal sold. But, with the great reduction in the cost, and facility in the use of heat, it would quickly be employed in a multitude of ways not now thought of; and not only the cooking and heating would be done by gas, but much of the work done by our servants would be performed by machinery; manufacturing of all kinds, and, particularly, those small industries that can be carried on in private houses, would multiply to an unheard-of extent. Our mills and machine shops, factories and furnaces, able to save enormously in their fuel item, would find wider markets for their products, and in a thousand other ways the consumption of fuel would be so greatly increased that the demands for coal would be fully maintained, and would soon assume proportions exceeding the most extravagant views of our most sanguine 'coal men.' So mote it be."

A Good Coating for Outside Brick Work is made by mixing 20 parts clean river sand, 1 of quick lime, and sufficient linseed oil to form a thin paste. This is also useful as a cement for broken stone.

MISCELLANEOUS.

The Cremation Question.—At the last meeting of the Dresden Society for Incineration, "Urne," it was announced that at the Brussels exhibition of Hygienic and Life-saving apparatus, the gold medal was awarded to the Siemens system. It was also announced that for the erection of an incinerating furnace in Saxe-Gotha, preparations for which have already been made, considerable contributions have been received. The agitation on behalf of incineration, it was stated, is making slow but steady progress in other countries. [*Nature*, xiv, 581.]

Drainage of the Eye-Ball.—Dr. D. Weeker has introduced another new operation in ophthalmic surgery. It consists of a system of drainage effected by the introduction of a piece of gold wire through the membranes of the eye, which is so arranged that the patient is in no way inconvenienced by its presence. This new method is applicable to all cases in which the drainage of a liquid from the eye would be indicated, such as hydrophthalmia, staphyloma, detachment of the retina, absolute glaucoma, etc. Thus far the results have been encouraging. [*British Medical Journal.*]

The Vitality of Seeds.—The extraordinary stories, which from time to time find their way into the public prints, concerning the remarkable vitality of seeds, based upon the alleged sprouting of wheat found associated with Egiptian mummies that have been entomed for thousands of years, or the recently circulated assertion, of the germination of the seeds of the poppy found in the refuse slag heaps of the ancient silver mines of Lanrium, worked several thousand years ago by the Greeks, are explicitly denied on the authority of Mr. Meehan, the eminent botanist and editor of the *Gardener's Monthly*. In the last issue of that journal, we find the following reply to a correspondent, who inquires what the editor thinks of the Lanrium poppy story, viz:—

"Glauciums with 'a beautiful yellow flower' are common enough in Greece. Why do not people who are anxious to know 'what to think' about these things, put a few glaucium seeds in a bottle, seal the bottle air-tight, and bury in the earth. We would give the 'silver mines of Laurium' if we owned them, against the seeds remaining vital five years, to say nothing of twenty hundred years. Some day when the Grecians get as many railroads as we have, and as active scientists to investigate, we fancy plenty of things "unknown to modern Botany," will be found all around them. We know of *no* evidence satisfactory to us, that any seeds have been found vital under the extraordinary circumstances claimed. The whole theory of great vitality through long periods when buried in the earth, is at best founded on nothing but shrewed guesses."

A New Iron Steamship, for C. H. Malleroy & Co's Texas Line, was launched from the ship yard of John Roach & Son, at Chester, on October 21st. The new vessel was christened the *Rio Grande*, and makes the twenty-third iron steamship built for commercial purposes in the above yard within three years and a half. The *Rio Grande* is asserted to be the strongest vessel yet built in this country. She has two iron decks, one laid all the way, and the other two-thirds of the way fore and aft, and both flush to the sides. Her principal dimensions are, extreme length, 310 feet; breadth, 39 feet; depth from spar deck 21, and from hurricane deck, 29 feet. Engines compound, with high and low pressure cylinder respectively 32 and 60 inches diameter, and 54 inches piston stroke. [*Bulletin Am. Iron & Steel Assoc'n*, x, 291].

Precautions in Case of Fire.—Keep all doors and windows of the structure closed until the firemen come; put a wet cloth over the mouth, and get down on all fours in a smoky room; open the upper part of the window to get the smoke out; if in a theatre, keep cool; descend ladders with a regular step to prevent vibration. If kerosene just purchased can be made to burn in a saucer by igniting with a match, throw it away. Put wire-work over gaslights in show windows; sprinkle sand instead of sawdust on floors of oil stores; keep shavings and kindling wood away from steam boilers, and greasy rags from lofts, cupboards, boxes, etc.; see that all stove-pipes enter well in the chimney, and that all lights and fires are out before retiring or leaving place of business; keep matches in metal or earthen vessels, and out of the reach of children; and provide a piece of stout rope, long enough to reach the ground, in every chamber. Neither admit any one if the house be on fire, except police, firemen, or known neighbors; nor swing lighted gas-brackets against the wall; nor leave small children in a room where there are matches or an open fire; nor deposit ashes in a wooden box or on the floor; nor use a light in examining the gas meter. Never leave clothes near the fire-place to dry; nor smoke or read in bed by candle or lamp light; nor put kindling wood to dry on top of the stove; nor take a light into a closet; nor pour out liquor near an open light; nor keep burning or other inflammable fluids in rooms where there is a fire; nor allow smoking about barns or warehouses.—*Dr. Hall.*

A Hint for Nervous Orators.—That distressing sensation known as stage fright, which often afflicts persons inexperienced in speaking before a large audience, can be removed by a few whiffs of ether. Dr. Wm. Fuller, of Montreal, says that either this remedy or a minute dose of morphia will remove all the spasm of the cerebral vessels and violent palpitation of the heart, and obviate the confusion and forgetfulness with which the sufferer is usually seized, so that he does not have to wait for symptoms of reaction to set in to allow him to "get warmed up," as the saying goes. Too large doses of either remedy, it should be remembered, produce the opposite condition of the vessels, quite as fatal to a successful result. An objection is that reliance on this means may lead to a dangerous habit. [*Sci. Am.*, xxxv, 319.]

BIBLIOGRAPHICAL NOTICE.

The Use and Abuse of the Steam Boiler. By STEPHEN ROPER, Engineer, author of "Roper's Catechism of High Pressure or Non-Condensing Steam-Engines," "Roper's Hand-book of the Locomotive," "Roper's Hand-Book of Land and Marine Engines," "Roper's Hand-Book of Modern Steam-Fire Engines," etc., etc., etc. 348 pp.; tucks. Price $2.

The publishers, Messrs. Claxton, Remsen & Haffelfinger, Phila., send us a copy of this work, as "the only book ever published in this country, exclusively on steam boilers." While Mr. Roper's compilations are in many respects open to professional criticism, they have in them so much sound common sense and practical information, that we must thank him for doing just what others have very largely, if not entirely, failed in—reaching and teaching the average practical engineer. G.

CENTENNIAL NOTES.

BEYER BROTHERS' MACHINERY FOR THE MANUFACTURE OF SOAP AND PERFUMERY.*

II.

The firm construct two other machines which are very useful in the manufacture of toilet soap. One is intended for washing and the other for grinding and chopping the fatty substances used by soapboilers. The fat-washing machine, fig. 10, consists of a stamper working up and down in guides,

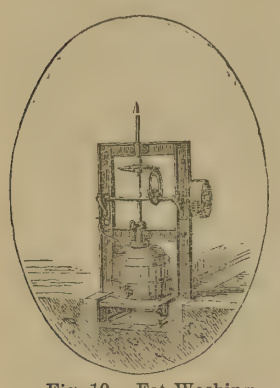


Fig. 10.—Fat Washing Machine.

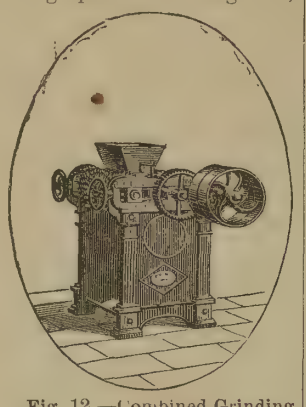


Fig. 12.—Combined Grinding and Chopping Mill, with four raised surface cylinders

and which, by means of the rotary motion of an eccentric meeting a face-plate fitted to the rod of the stamper, imparts to the latter a vertical up and down motion, combined with a rotary motion. The fat contained in the vat is thus not only kneaded, but thoroughly washed by the stream of water running through it.

The combined grinding and chopping mill, Figs. 11 and 12,

Fig. 11.—Combined Grinding and Chopping Machine, with two raised surface cylinders.

consists of two, or sometimes four, cast-iron cylinders, fluted longitudinally in the direction of the circumference, so as to form very strong teeth engaging one another.

The manufacture of household or family soap does not require machinery to the same extent as that of toilet soap. The process may be subdivided into nine separate stages, viz :—

1. Preparation of the lye.
2. Boiling with weak caustic lye.
3. Separation of the viscous mass.
4. Racking off the lye.
5. Boiling of the soap.
6. Mottling.
7. Melting.
8. Cutting.
9. Dividing into bars.

The first seven of the above operations are chemical in their nature ; the last two, namely, the cutting and dividing, are mechanical processes, and necessitate the employment of machines. These Messrs. Beyer Frères likewise manufacture :

For cutting, a machine is used which is known by the name

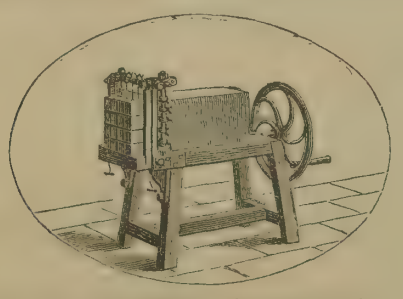


Fig. 13.—Soap Slicing or Carving Machine.

of slicer or carver, Fig. 13. It is fitted with a movable table, which works under the action of a fly-wheel and handle, and with a frame bearing vertical and horizontal blades, the distance between which may be altered according to the weight of the bars to be produced. Thus, the block of soap is first cut up in both directions, and then a wire, working in a frame, detaches the squares from the block.

* French Section, Machinery Hall.

The soap, after being thus cut up into squares, merely requires shaping, marking, and lettering according to the wants of each particular maker.

For this purpose a hinge-jointed mould, fig. 14, is used, which is constructed to open on the four sides, and which, when submitted to the action of the press previously described, strikes and impresses the soap upon the six faces at one operation.

[To be continued.]

THE TIME GLOBE.

The Time Globe is a miniature representation of the earth in its daily motion, the globe revolving once in twenty-four hours by means of the mechanism within it. As the globe revolves, the time of the various meridians or localities is indicated on a large dial encircling the globe at the equator, while the mean time of the place where the clock is used is shown in the ordinary way by two hands and another dial at the north pole. This clock is therefore a universal timekeeper. It has a sliding vernier divided into 360 degrees, by means of which the latitude of localities can be ascertained, or the proper degree of inclination of our own or any other heavenly body illustrated. By setting the globe at the proper angle of inclination, giving the poles the proper direction north and south, and letting light, properly applied, fall upon it, it will give, not only the amount of light or darkness each country has, but the very time at which it has it. The clock therefore gives the time, longitude and latitude, of any place in the world, as well as the difference of the same between two or more places.

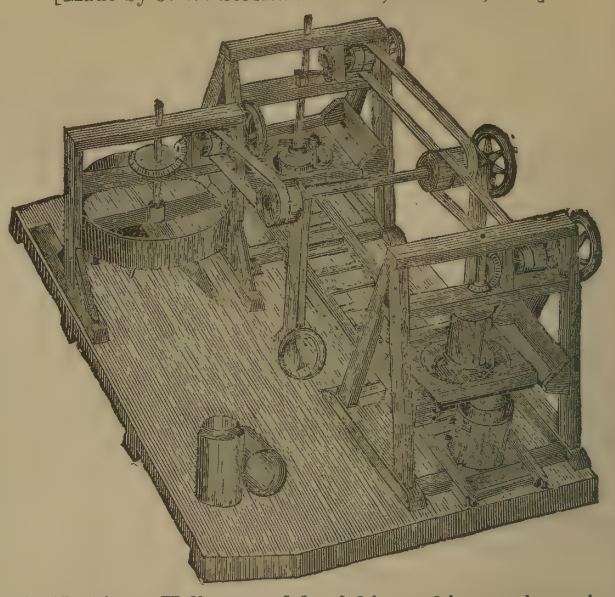
This device is made by L. P. Juvet, Glen's Falls, N. Y., and is exhibited in the Government Building, under the care of the Smithsonian Institution.

—Messrs. Kreider, Campbell & Co.'s exhibit of Machinery was driven by a horizontal engine with variable cut-off, and regulated by an Allen Governor; for which excellent regulator—illustrated and described in detail in our issue of September 16th—the firm mentioned is now agent. Messrs. Kreider, Campbell & Co. built this engine specially for this service, and state that during its steady run of several months, it has not been out of order once. This particular Allen Governor is stated to be the first brought to Philadelphia.

—*Schaeffer & Budenburg*, of Buckau-by-Magdeburg, exhibit in the German Section of Machinery Hall, a fine selection of steam, water, and vacuum gauges, of their well-known manufacture; and also exhibit two emery grinding machines, for surfacing, with flexible aprons, on which (instead of on a rigid table) the material to be surfaced is placed.

CEMENT PIPE POWER MACHINE.

[Made by J. W. Stockwell & Co., Portland, Me.]



In Machinery Hall are models of this machinery, shown in the annexed very poor engraving. The cylinder in the left background is the *mixer*, for mixing dry cement and gravel ; it will also mix them after they are wet. The makers claim that it will mix in three minutes as much as two men can in ten minutes.

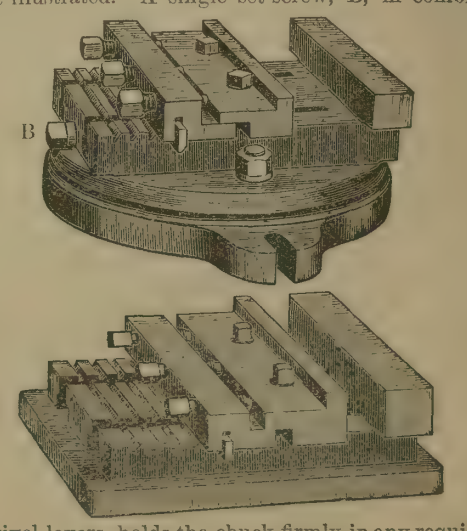
There is a tub with a revolving mixing blade, one end of which presses the stock against the bottom of the tub, breaking up the lumps. The other end of this blade bears a moldboard and turns the stock over. After dry mixing, wet mixing succeeds ; and the mass is then dropped through a trap-door. It is then shoveled into the hopper of the "revolver," in the right foreground. This hopper has a funnel-shaped part to hold the upper end of the outside pipe-mould, when it is under the centre of the spindle. This spindle is grooved on two opposite sides, to hold splines which are in the upper end of a revolving packer ; which last is a sheet metal cylinder, and is lowered down into the space between the outside pipe-mould and the pipe-core, when a pipe is to be made. This packer has on its upper end a casting having splines to slide in the grooves mentioned. On the lower end of the packer is a short cast cylinder with sled-shoe-like devices, for pressing the stock between the case and the core of the pipe-mould. The cylinder is made to revolve while the stock is being fed in ; and as the stock falls, the shoes press it down, rising thereon as it is fed in. This makes round pipe of any diameter, in sections two feet long, and at the rate of from a half-minute to one minute each. One man could make a section in from five to eight minutes, by hard tamping.

In the left foreground are shown two sections of pipe, showing the male and female beveled ends.

In the right background is shown (very imperfectly) a "tamper" for making all sizes and shapes of pipe. The tamping rod is lifted by a cam, and is made to travel around the core, tamping and rising on the stock until the mold is filled. G.

PROUTY'S PLANER CHUCK.

The cuts show an excellent planer chuck made by A. F. Prentice, Worcester, Mass. Both square and round swivel base are illustrated. A single set-screw, B, in combination



with swivel levers, holds the chuck firmly in any required position. The chucks are conveniently graduated. The latch-strip, which operates in suitable serrations, is shown in both cuts.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, NOVEMBER 25, 1876. NO. 21.

THE LYALL POSITIVE MOTION LOOM.

(THE GREAT TEXTILE INVENTION.)

Among the blessings conferred upon the human family by the employment of machinery, the loom takes very high rank; nor can one realize its full importance until he ponders for a moment what would be the conditlon of our people were we compelled to again resort to hand weaving. Power weaving has had an existence extending over some two hundred years, and during that period its history has been marked by but few radical and *permanent* improvements. Among these stand prominently out the flying shuttle invented by John Jay in 1840. The Jacquard loom invented by Jacquard about 1797, and the Lyall Positive Motion Loom, lately invented by James Lyall.

Each of these inventions has completely filled its sphere, the last being an improvement of and advance upon the first, which was rendered necessary because a flying motion is not a positive one, entails an irregular speed of motion, is violent in its action and furthermore, no mechanical movement whose duty it is to strike a blow, can be made either durable or even comparatively noiseless. These are the defects as applied to the motion as a mechanical movement, irrespective of its effect upon the material upon which it is made to operate. These disadvantages, however, are, when such a motion is applied to weaving, supplemented by others of indisputable and vital importance, as we shall now proceed to demonstrate, first premising our remarks, however, by noting the fact that sudden and violent mechanical movements have always been abandoned, in all classes of machinery, so soon as a more regular and positive means has been discovered which would perform even an equivalent of duty.

The flying shuttle is a mere projectile whose speed is the greatest after it first receives the blow which imparts to it its flight, and diminishes as it travels; the whole movement being wholly without the control of the weaver. The shuttle in its flight rests upon the warp thread, and it is obvious that at the commencement its friction must be very great, because sufficient force must be imparted to it to travel the entire required distance, notwithstanding that the friction referred to is offering resistance to its flight at every point of its travel. The effect of this friction is found in practice to cause a frequent breakage of the warp thread and a constant injury to the filaments of any delicate fabric whatever. More especially does this occur at the commencement of the shuttle flight, where its speed is greatest. As a result it is altogether impracticable to weave, with a fly shuttle, goods of a great width, even if the materials woven are of the coarsest and strongest nature. The wider the warp is, the more difficult it is to pick it, because the shuttle requires a harder blow; its initial flight (and hence its friction upon the warp) is greater, and its whole velocity being increased to insure its full flight, notwithstanding any variation in the warp which might occasionally tend to check its movement, it usually ends of its flight at an excessive velocity, and hence it is harder to stop it. Nor is this all; for the power required to stop it entails a double loss of power in driving the loom, for the shuttle is first given a force of flight more than that necessary to the distance of its travel, and then the loom has to oppose that extra power and reverse it, thus entailing a loss of motive power, in amount, twice that due to the velocity and weight of the shuttle when at the end of its flight.

Another and very serious defect in projected shuttle movements, lies in that the stoppage of the shuttle inevitably imparts to it a rebound which slackens the weft or even leaves a bight in it, and adjust the speed of the shuttle as delicately and correctly as we may, this rebound and its evil results can never be entirely removed.

It does not matter how well the loom is made, or how expert the weaver, *the terminal speed of the flying shuttle cannot be made constant;* and as an inexorable result, the rebound varies so that some of the threads are loose and some tight; and when the fabric is woven, the tight ones take the strain and the loose ones impart no strength whatever to the goods. The strength of a piece of goods is that of its weakest part; and a single defect, therefore, becomes a permanent and irremediable blemish. *The speed at which the loom runs must and does affect the flight and rebound of the shuttle, every variation being recorded in the goods with unerring accuracy.* From these causes it often occurs that, from either the rebound of the shuttle or its failing to pass through the threads, it is struck by the lay, the dents of the reed are broken and the threads of the adjacent warp are destroyed. In weaving fine materials the bending even of the dents is practically irreparable, since it produces a fabric with a slackly woven streak in it.

Another and very important point is that the selvage of many kinds of fabrics is one of the criterions by which the quality of the goods is estimated. Now all the defects inherent to the rebound manifest themselves most plainly in the selvage. And let the adjustment be as perfect as it may, it is not automatic, and cannot, therefore, remain constant under variations in the speed of the machine, imperceptibly fine variations to the threads, and the thousand and one influences that may affect it, such for example as that the picker rarely strikes it so as to propel it in identically the same line of motion; and the shuttle occasionally flies out of the loom, and hence the enormous amount of study which has been directed to discover some mechanical means whereby its speed, and the checking and reversing of its motion could be made uniform and positive.

The air pump pick was an attempt to drive the shuttle by compressed air, but it failed. Another device includes a long needle arm, which conveys the shuttle through the warp and withdraws until the lay is beaten, and then returns to catch the shuttle and draw it back. This may be seen at the Centennial Exhibition, where it is in operation upon a carpet loom, for which class of machine it is best applicable. The double weft thus laid—useful as it is for ingrain carpet—is inadmissible for other fabrics.

Another device possesses two hook arms and dispenses with the shuttle; one arm carries the bight of the weft for half the distance of the weft travel, and there delivers it to the other arm, which, operating from the other side, carries the bight the rest of the travel. For short throws, such as are required in weaving ribbons, etc., a rack and pinion movement has been introduced, and is noteworthy as being at least a positive motion. Of other and unsuccessful devices it is unnecessary here to speak; since their standing calls for no recognition.

All the defects above noted are obviated in the Lyall Positive Motion Loom, the shuttle of which is shown in our engraving at Fig. 1; where the shuttle is shown *resting upon its carriage*, B.

The operation of the positive motion shuttle may be thus briefly described: Fig. 1 represents the carriage, its metal raceway or guide and the shuttle; and in order to clearly understand the action we will first consider the motion and operation of the carriage, B, leaving the shuttle, F, for the time being altogether out of the question. In Fig. 1, A, is an iron raceway or guide extending from end to end of the loom, and along this raceway rolls the carriage B, the wheels, C C, resting on the bottom of the raceway. A continuous belt, G, passing over grooved pullies, one at each end of the loom, and with its two ends attached, at opposite ends, to the carriage, and operated by a suitable mechanical device (shown in Fig. 2) pulls the carriage back and forth along the guide or raceway beneath the warps. And the movement of the carriage causes the rollers, C C, on which it rests, to revolve. The rollers, C C and D D, being in contact, a rotary motion is therefore imparted to the latter. Now the warp threads stand in a line from the top of wheel, D, to wheel D; and the only point where these threads have contact is between the wheels. If we suppose, then, the carriage to be travelled back and forth, the only action upon the warp will be to slightly lift it as the wheels, D D, pass. Now let us place the shuttle in position on top of the warp and the latter will be between the wheels D and E, respectively as in Fig. 1. And as the carriage is operated reciprocally clear across the warp threads, the wheels, C C, operate the wheels D D, and the latter operate the wheels, E E, of the shuttle. Here a peculiar, though very simple, action takes place; for since the sizes of

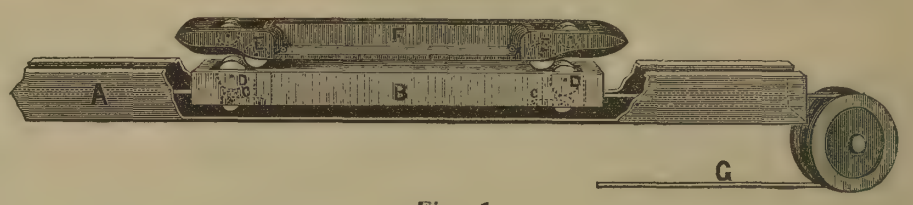


Fig. 1.

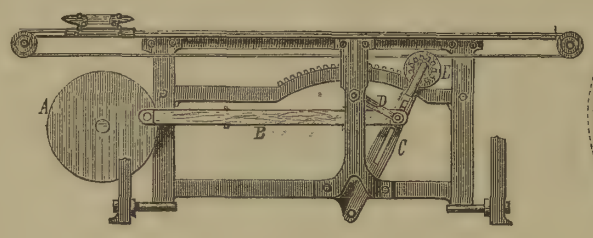


Fig. 2.

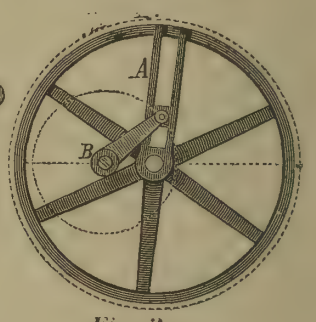


Fig. 3.

the wheels C C and D D are precisely alike, the speed at which the bottom of the wheels C C pass the bottom of the raceway and that at which the wheels D and D pass the warp threads is exactly equal, and hence no lateral movement or strain whatever is placed on the warp threads, the latter being merely slightly raised perpendicularly as the wheels D D pass. The warp does not pass the wheels, but the wheels travel past the warp, merely compressing it, while at the same time imparting motion to the wheels E E of the shuttle, and since a compressing strain tends rather to strengthen than to weaken a filament, the action is, in every way, a desirable one. The wheels D D do not contact with the wheels E E, but are intended to roll along the upper surface of the raceway or guide, keeping the shuttle to its work; the weight of the shuttle, however, relieves them from any active duty. The pathway or guide in which the carriage travels surrounds the latter, save where the uppermost wheels protrude; hence the carriage cannot get out of its proper position.

It is obvious that it is highly advantageous that the motion of a shuttle should be to travel as quickly as possible in the middle, and should lose in speed as it approaches the end of the travel. This is desirable for two reasons; first, it gives an easy reverse motion to the shuttle, and one requiring less power to perform it; secondly, it gives more time after the shuttle has left the warp in which to beat the lay; while in the middle of its travel, where alone it is desirable, the shuttle may travel at its maximum speed. These are the mechanical requirements of the conditions under which all huttles, of whatever kind, operate, and the manner in which they are, in the Lyall loom filled, is as follows. In Fig. 2, A is a crank disc; B is a connecting rod, having pivoted to its end a die working a sliding fit in a slot provided in the lever C, which lever is pivoted at the bottom end. D is a short link pivoted to the frame at one end, and, at the other end, pivoted by the bolt or pin which passes through the die, the connecting rod and the end of the link D. As a consequence of this arrangement we have as follows: Suppose we detach the rod B from the crank pin of the disc A, and then pull the connecting rod at a regular and uniform speed horizontally towards the point A of the disc, then at the other end of the rod the link D will move the die, and that end of the connecting rod, down the slot in the lever C, until the arm D stands perpendicular, and after that the die would commence to ascend the slot again. Now with the same amount of connecting rod movements the upper end of the lever C will move through a distance greater in amount in precise proportion as the die is nearer to the lower end of that lever, and as a natural result, even were the motion of the connecting rod at the crank pin end, a reciprocating one and uniform in speed, the upper end of the lever C would travel faster in the middle than at the ends of its travel, and thus would the dwell in the shuttle be obtained. In addition to this, however, the motion of the crank pin end of the connecting rod is a rotary one, and, since the disc travels at a uniform speed, the connecting rod is given but very little lateral motion when the crank pin is on its dead centers; and here again is a dwell in the motion of the shuttle obtained, the combined dwells being ample and obtained by an easy, simple, and durable mechanical movement, free from all the wear, tear and uneven action which always attends the use of cam movements. At the end of the lever C is the pinion E, and the pulley wheel actuates the shuttle belt or band shown at G, in Fig. 1. The pinion E is pivoted to the end of the arm C, and revolves on the fixed rack, which is the section of a circle struck from the pivoted end of the lever C. The use of the rack, therefore, is to cause the pinion E to revolve in a direction corresponding to that in which the lever C is traveling. The slow motion thus given to the shuttle at each end of its travel insures that the lay is got well home before the shuttle returns, so that no matter in what position the shuttle is to the race when the loom is stopped, the first thing done on starting the loom again is to draw it automatically out of the way of the lay.

When the shuttle has a very long travel, as in the case of weaving wide fabrics, dwell is given to the lay, the motion in this case being illustrated in Fig. 3, in which A represents a revolving wheel provided with a slot in one of the arms. Into this

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WILLIAM H. WAHL, PH. D., ROBERT GRIMSHAW, PH. D., } EDITORS AND PROPRIETORS.

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slot fits a sliding block, pivoted to the end of a crank arm fixed to the shaft B, and this shaft it is which operates the lay. The dotted circle shows the path of the crank pin or pivot of the sliding block when the wheel revolves; and it will be seen, then, that the sliding block moves up and down the slot at each revolution of the wheel. Now it is obvious that the speed in feet per minute of any point on the wheel is greater as we approach its perimeter, and we have as a natural result that, since the wheel revolves at a uniform speed, it imparts to the crank pin a motion quicker when the sliding block is nearer the perimeter, and slower when it is nearer the centre of the wheel A, so that when the sliding block is at the wheel centre the motion of the crank is so slow as to be almost motionless, and it is at this part of the motion that the lay is beaten. Here again, then, we have a positive and even movement giving a regular, uniform and smooth motion for the dwell of the lay.

The display made by Messrs J. & W. Lyall at the Centennial Exhibition, and shown in continuous operation, includes a loom weaving a fabric 8 yards wide, a feat never attempted by any other machine; the duty being 320 yards woven per day, and the operator being a young girl. This loom is shown on the left of our illustration. The three machines standing opposite are a bag loom, a ten-quarter cotton loom, and a heavy jute carpet loom.

The bag loom weaves four seamless bags simultaneously, the four shuttles operating in one raceway; their travel being such that each in passing from one side to the other occupies the position vacated by its neighbor. The bottom of each bag is closed in the weaving, so that it is merely necessary to detach the bags one from the other. The weaver is enabled to examine both sides of her work, and thus defects in the under sides of the bags can be avoided; a feature in which many other looms are lacking. This loom travels at the rate of about 120 picks per minute, and promises to monopolize its field of operation. The ten-quarter loom is shown weaving sheeting at a speed of about 96 picks per minute; the action of this loom and the quality of its work are both superior. Similar looms are in operation at the New York Mills, of Utica, N.Y., and the Wamsutta Mills, of New Bedford, Mass. The carpet loom shown in the distance has a cop in its shuttle to make heavy jute, or striped carpet, of which it turns out about 100 yards per day.

The corset loom weaves four webs of corsets at once, leaving the form as complete as can be produced by hand work, and turning out eighty-four corsets per day. The means by which the gussets, welts, etc., are formed is that the Jacquard governs the quantity of warp to be kept in action, so that when the projecting parts of the corset are being woven, the weft is only supplied to those parts by the travel of the shuttle being shortened, and by only the necessary portion of the warp being kept in play. By a simple arrangement in the shuttle the weft is kept uniformly tight, no matter how long or short its travel may be; furthermore, only those parts in which the weft is laid are fed from the loom, so that no matter how irregular the form being woven, the weft is always a straight line and of equal tension and closeness from end to end.

The Lyall loom possesses a field entirely and completely its own, and is distinctive in that it substitutes easy and positive mechanical motion, having wearing surfaces of the most desirable construction in place of violent and irregular ones, replacing uncertainty by certainty, while effecting an economy of motive power. Next to the positiveness and ease of the motion, however, we consider the fact that that motion is in precise accordance with the requirements of its duty, to be of the greatest importance; for the motion of the shuttle had hitherto been, compulsorily, designed to get the shuttle by hook or crook through the warp, and the width of the goods woven was limited to the distance it was found practical to effect this object. It was impossible, under these conditions, to pay any attention to the requirements of the weft; whereas by the Lyall motion the weft is laid evenly, regularly, and under precise and determinate conditions, which conditions can be regulated to suit any requirements possible to the art of weaving.

JOSHUA ROSE.

SPECIAL NUMBERS.—In our next issue (Dec. 2) we shall publish Mr. JOSHUA ROSE'S illustrated article on *Saws and Sawing*. Thirty six hundred extra copies of this number have been subscribed for by advertisers and others, and will be mailed by us to as many saw, shingle and planing mills throughout the country, and in addition to our regular list.

Arrangements are being made by which our issue of Dec. 23d, containing Prof. R. H. THURSTON'S article on *Lubrication* will have an extra circulation among five thousand manufacturing establishments in the United States. This number will also doubtless contain, besides the usual Editoral and Review matters, articles by Profs. J. E. SWEET, and S. W. ROBINSON; and Messrs. JOSHUA ROSE, J. W. NYSTROM, HUGO BILGRAM, and others.

In each of these numbers, advertising rates will be forty cents per line, except to our regular customers. Advertisements will not be permitted to encroach upon the reading matter.

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BRICK IN DECORATIVE STRUCTURE.

I.

The use of bricks as a building material dates from the highest antiquity; and at an early period assumed an importance commensurate with their convenience and value in construction. Many causes, however, had tended toward the abandonment of brick in favor of stone; and among these causes, the hitherto inadaptability of brick for higher ornamental purposes in outline, and its almost entire unsusceptibility of use where coloring was an important element in design. The cathedral builders of the middle ages wrought out in stone their most exqusite conceptions; conceptions that our modern spirit of sham has (where cost rather than truthfulness, has been an object) imitated in wood, stucco, and sheet metal; but which would have been impossible of execution or imitation in brick.

As use, however, rather than mere beauty, has reasserted itself as the desideratum in architecture, there has, within the past few years, been a revulsion of public feeling tending to the employment of this material more largely than ever. Perhaps the utter failure of stone in the nobler structures, when subjected to the ordeal of a great conflagration, and the general good behavior of the already vitrified brick, under the same trying circumstances, may be considered as the most important reason for the revulsion mentioned; a revulsion having for its only opposing barrier, the greater difficulty in handling the artificial material (monotonous alike in color and in form) so as to produce striking architectural effects; and here again was an obstacle, in the lack on the part of architects, of taste and experience in so using and arranging the material as to produce results creditable from an aesthetic point of view.

Difficulties in form having been somewhat overcome, there yet remained one element to counteract—the monotony in color.

The tesselated pavements of the earlier periods having been imitated and in a measure surpassed and superseded by those of vitrified tiles, enamelled and unenamelled, and ranging in design and color from the simple geometrical figure in monochrome, to the elaborate and brilliant designs of Minton, Maw and others—the employment of these tiles in mural decorative art became more and more common, and with results varying in pleasurable effect rather with the genius of the designer and the purse of his patron, than from elements inherent in the decorative materal,—concerning which last it may be said that its production and use tax the resources of the designer, the mechanic and the purchaser alike.

Following up the increasing use of brick, which may be termed the only fireproof material, we find that that regularity in color and in form, and that flatness, which at first seemed an insuperable obstacle to the popular use of brick in structures designed to be ornamental, became, when that regularity was so increased as to near perfection, a positive and powerful element in introducing brick into decorative structure. Absolute unifomity in color, size, shape, and smoothness of surface, rendered brick available as a background or field, upon which an art design might readily be traceable in stone, in tiles, or in brick of a different color than that of the "ground-work."

The rich red of the bricks of Philadelphia and of her sister city Baltimore, and the soft cream-hue of the Milwaukee product, serve admirably as backgrounds in mural structure, where their monotony is relieved with suitable contrasts in tile or stone—or in bricks of other colors—white and black. But in such cities as Pittsburg, Wheeling, etc., where the use of bituminous coal, and other causes, load the air with grime, we find that the combined influences of soot, dust and moisture, produce an effect depressing and unsightly. The absorbent nature of such bricks, too, may render them to a certain extent carriers, or rather reservoirs, of vicious germs, engendering fevers and other diseases akin to those which produced and disseminated them.

A further extensive annoyance, partly sanitary and partly commercial, is that ordinary bricks are apt to absorb moisture and give it out again under certain conditions, causing dampness in cellars and vaults, and in the latter places injuring papers or valuable goods contained therein.

We have already noted the admirable and nearly perfect fireproof qualities of well-made bricks, which will endure unscathed a fiery ordeal under which the best of granites will burst and disintegrate, and the most costly marbles and limestones calcine. If, then, we can cater to the aesthetic taste by devising an inexpensive brick that shall be non-absorbent of moisture or grime; can produce a decoration therefore, cheaper than encaustic tiles or stone; can show our regard for matters sanitary and commercial by preventing the absorption and retention of foul airs—we shall remove most of the stumbling blocks now in the way of architects and of builders.

The causes which give to bricks their fireproof qualities are homogeneity and vitrification. Limestone and its kindred are homogeneous, but calcine under the action of intense heat; granite has perhaps undergone a previous state of fusion, but its composite structure causes its complete disintegration under sudden and great alternations of temperature.

Brick possesses both the named elements of "salamanderosity," if the word may be coined.

To give other than a few and not very beautiful variations from the uniform and ordinary red, yellow, cream, white and black bricks, by the addition of a coloring material to the clay from which they are burned, would doubtless prove a very expensive task, and would not do away with the absorption of dirt, etc., previously mentioned. To paint bricks of good surface gives color and resistance to grime; but such

a surface is susceptible to discoloration by foul gases, and destruction by slight scorching or scratching.

To obtain an ornamental brick that shall be fireproof, waterproof, and dirtproof; shall be resistant of mechanical injury, unaffected by smoke or foul air, or any other ordinary destructive influences; and which shall, withal, be cheap, is a problem well worthy of solution.

If we can substitute for paint a skilfully applied surface-protection embodying the principles of homogeneity and previous vitrification, we have gone far towards the required solution. In other words, we must *enamel* our bricks. A proper enamel should defy frost and fire, grime and weather, and all the rest of the attacking agents. The full limit of durability of such enameled brick, we have no means of telling; but as the Chinese employed such in building their "Porcelain Tower" at Nankin, and as a thousand years' test have wrought no damage thereto, we may conclude that enameled bricks will do well enough—if cheap enough—for our use.

Until very recently, but few enameled bricks found their way into use in our country—those few being imported from Europe.

As, however, an enterprising American firm* has taken up, on a large scale, the manufacture and introduction of enameled bricks, we deem the matter of sufficient importance to devote a further article to a description of the entire process of manufacture, as conducted at the works of the company referred to. G.

[*To be continued.*]

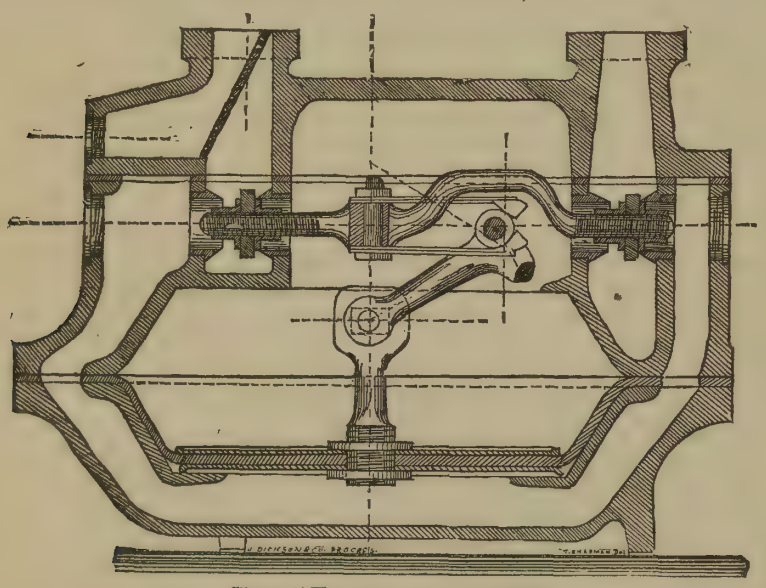
WATER METERS.

IV.

Mr. J. W. Maclay, of 231 Broadway, New York, furnishes us with the points for the following description of the "Fountain" meter; and may be addressed as above for further particulars.

The body of the meter consists of two cast-iron basins, joined together by bolts, having a lid at the top containing the openings for the inlet and outlet of water. Two balanced valves admit the water alternately above and below the movable diaphragm. A valve stem, controlled by a spring, regulates the entrance and exit of the water. The diaphragm is of India-rubber, supported by metal plates. A bent lever moves the valve-stem by means of the spring and friction roller, as well as an arbor, which in its turn, communicates motion to the ratchet-wheel of the registering apparatus. A central stud, having an eye at the top, and its lower end attached to the diaphragm, with which it moves, causes the lever to describe an arc of a circle.

The main part of the apparatus is the valve-stem, which bears the valves and



THE "FOUNTAIN" METER.

the spring for the purpose of giving them motion. This stem is completely isolated, having no guides or bearings of any kind, and, as the valves at its ends are perfectly counterbalanced, the water has no effect upon it, and it is therefore exclusively controlled by the action of the spring, whose object is to communicate to its oscillating movement.

The water, pressing on the upper and lower sides of the diaphragm alternately, causes an up-and-down reciprocating motion of the same, moving the stud and lever, making the center of the friction-roller vary and spread out the spring arms; and when their angles and the centres of the rollers are on a level, there is produced a tripping motion, which has the effect to change or close the valves in contrary directions, and to throw the pressure of the water alternately above or below the diaphragm. At the same time, as this change is effected, the arbor is turned so as to move the index. In order that the flow may be more rapid, the lever is provided with three friction rollers. The makers claim that, "while the water is passing into the measuring-chamber on one side, precisely the same quantity of water is being discharged from the opposite side of the diaphragm, the flow smooth and without interruption. The meter discharges a uniform measure of water at each movement of its diaphragm under any variation of pressure."

As it is an almost invariable custom to submit even our shortest items for *verification* by those interested, before publishing, there is ample opportunity for orders to be sent in time for filling. We guard the inventor, maker, or seller, against inaccuracy; and would like to guard the public against misstatement, and ourselves from misquotation.

* "The Brick Enamelling Co., of Philadelphia," 309 Walnut Street.

FLUOR SPAR AND ITS USES.

II.

HYDROFLUORIC ACID.—This acid is prepared by gently heating a mixture of finely powdered fluor spar with twice the weight of the oil of vitriol in a retort of lead or platinum. The mixture becomes pasty, swells considerably, and a suffocating acid vapor distills over. This is condensed in a liquid in a lead or platinum receiver kept cold by a freezing mixture; for many purposes a dilute solution of the acid is required, in which case the mouth of the retort is allowed to touch the surface of the water, in a vessel of lead, platinum or gutta-percha.

Use in Etching.—It may be employed either as a vapor or in dilute solution. When the vapor is used, the mixture of spar and oil or vitriol is placed in a shallow dish of lead, or as the purity of the gas in this case is of little consequence, in a stone-ware vessel. The glass to be etched is slightly warmed, a thin coat of beeswax or paraffine applied, and after the design has been engraved, it is placed with the coated side downward upon the vessel. Sufficient heat is applied to liberate the gas without melting the coating, and the operation is continued until the lines are etched deep enough; the coating is then removed by turpentine or benzine.

In other cases, as in the graduation of thermometers, etc., the dilute acid may be used with advantage. The tube is first coated with engravers' etching varnish. The divisions are cut in the varnish with a fine point, and after immersion for a few minutes in a long leaden tube filled with dilute acid, the scale is permanently engraved.

A combination of the acid with the sand blast has lately come into use for the etching of ornamental designs upon glass.

Use as a Solvent.—The dilute acid gradually dissolves the metals, excepting platinum, gold, silver, lead and mercury. Hydrogen being liberated, mixed with nitric acid it dissolves ignited silicon and titanium, but is without action on the nobler metals, such as gold and platinum. It is also useful to effect the solution of bodies such as silica, titanic, molybdic and tungstic acids, which are not soluble in sulphuric, nitric or hydrochloric acid. As a solvent for silica, which constitutes sand, quartz-rock, and in combination with various bases, the greatest number of minerals and rocks, it is invaluable. Such a silicate, for example, as felspar, composed of alumina and potash combined with silica, is readily decomposed when gently heated in a powdered condition with hydrofluoric acid. The excess of acid, and fluoride of silicon are expelled on heating, and the alkali can be extracted from the residue, or the gas directly after liberation from a mixture of fluor spar and oil of vitriol may be made to come into contact in a closed vessel, with the finely powdered mineral, previously moistened with dilute sulphuric acid. The latter process however is tedious, requiring several days for its completion.

HYDROFLUO-SILICIC ACID.—*Preparation.*—Equal parts of fluor spar and glass, both finely powdered and well mixed in a glass retort, with six parts of the oil of vitriol. Instead of glass, fine white sand may be used also. On applying a gentle heat, fluoride of silicon escapes in a gaseous form, and if allowed to come into contact with water suffers decomposition into silica and hydrofluo-silicic acid.

Uses. 1st. In the separation of the alkalis from their previous combinations, and obtaining them in a caustic or carbonated condition; this use depends on the property which hydrofluo-silicic acid possesses of forming insoluble compound with the alkalis. The potash has been separated from the potash salts occurring in certain deposits of rock salt. In this manner a saturated solution of the chloride of potassium is decomposed by a sufficient quantity of hydrofluo-silicic acid. When the gelatinous precipitate of silico-fluoride of potassium has settled, it is filtered off and dried. The silico-fluoride of sodium may be prepared in the same way. The silico-fluorides are decomposed by long continued heating; fluoride of silicon escaping, and the fluorides of sodium or potassium remaining behind. These fluorides are then decomposed by caustic lime or carbonate of lime, caustic alkali or alkaline carbonate being found according as the former or latter is employed. Fluoride of calcium is also produced and used over in the manufacture of hydro-fluosilicic acid.

2d. It has been proposed to use silico-fluoride of potassium to restore potash to the soil.

3d. For the decomposition of bones and phosphatic minerals in the manufacture of artificial fertilizers.

4th. In sugar factories for the removal of the alkaline salts from the molasses.

5th. It has been proposed to use hydro-fluosilicic acid in the making of glass and porcelain; in the manufacture of glass instead of lime to use the silico-fluoride of calcium, and instead of carbonate of potash, the silico-fluoride of potassium. A serious difficulty, however, is encountered in the liberation of fluoride of silicon in the glass melting.

6th. It is recommended for the production of artificial stone; for the fixing of colors in stereochromy; and the manufacture of tartaric acid in dying, etc.

7th. In the working of metals; to develope a beautiful plating upon brass, bronze, zinc and German silver.

8th. Patents have been taken out in England for the treatmeat of ammoniacal waters with hydrofluosilicic acid and fluoride of silicon, and the recovery of the ammoniacal salts from the precipitate. [Report by Prof. A. R. Leeds.]

THE AUTHORSHIP OF OUR ARTICLES.—Items or articles taken from other journals are invariably credited, as fully as possible, to their proper source. The authorship of those prepared especially for the REVIEW is, in nearly every instance, plainly indicated. Of the editorials, those signed "W." are by Dr. Wahl; those over the letter "G." are Mr. Grimshaw's. Other contributors usually sign in full; where initials are used, they will generally be recognized.

There are two prominent London journals: "*Engineering*" and "*The Engineer.*" Correspondents who refer to or address "*THE EngineerING,*" are apt to cause much confusion thereby.

Fig. 13.—BELT SHOP.

Fig. 14.—SCARFING MACHINE.

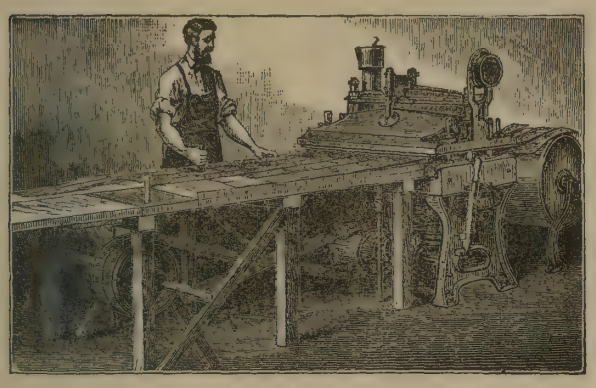


Fig. 15.—POWER PRESS FOR MAKING JOINTS OF BELTS.

Fig. 16.—POWER FINISHING AND WINDING MACHINE.

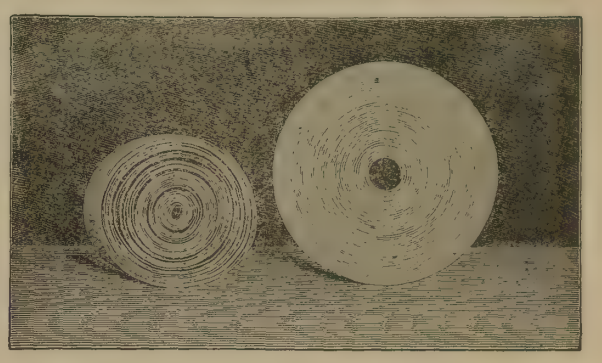


Fig. 17.—THE OLD WAY AND THE NEW.

IMPROVEMENTS IN THE ART OF BELT MAKING.

III.

The Belt Making. A good idea of the general method and extent of this department is given in the engraving (Fig. 13). The leather, on coming into this room, is straightened on one side. After this it is stripped very rapidly through a gauge into various widths as wanted. After this process the strips are carefully examined; and the various widths are packed by themselves and stored until required for the next process, when they are taken to the fitting tables and properly divided to various rolls, so that uniform thickness in each roll shall be secured. The waste is then cut off. The strips so prepared are transferred to the scarfing machines. These machines are operated as shown in Fig. 14.

The strip is held by a friction clamp roll, near which is seen the left hand of the workman. The part to be scarfed down to form the splice is placed over a knife, and with the right hand a roller is dropped down upon the leather. The treadle is then depressed; this applies the power communicated by the belt at the left of the machine, and a perfect scarfing is instantly effected. The whole operation is the work of a very few seconds; and the work done is immeasurably superior to that by the old hand process.

These strips with splices all prepared are now ready for joining together in the continuous belt.

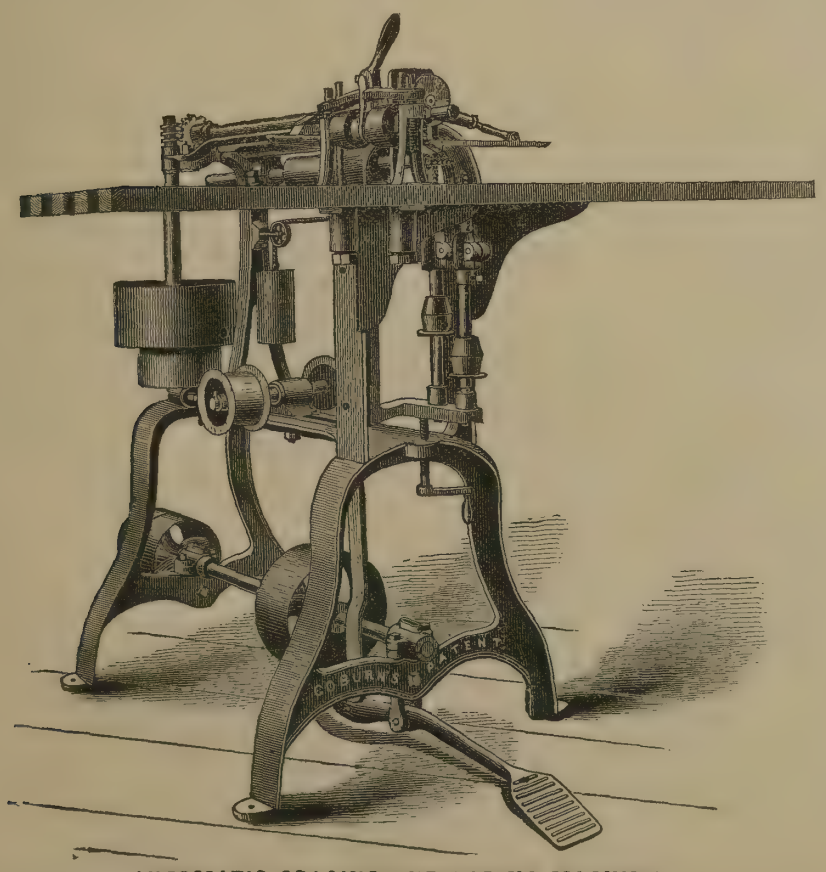
A cement, especially prepared for the purpose, is applied to the connecting parts; and the lap is then placed in the press, where it is subjected to a heavy pressure, remaining in this position until the cement is "set." This press takes the place of the hammering in the old style process. Its advantages are not only saving of labor, but a lap much better, and much more uniformly secured.

After the pressing, the belting is measured into coils of the required lengths, about 300 feet being the usual standard. Copper rivets are put into the laps at the tables, and on the tables, burs are fastened to the rivets on the opposite side of the belt. This is the usual manner of fastening the laps. Sometimes, however, belts are made to order, where, instead of riveting, the laps are sewed either with lacing or waxed thread.

Only the final operation remains to be described. This is the winding and finishing of the coil. The machine stands on the extreme left. Its working is more plainly shown by this larger plan of the same machine (Fig. 16).

The same motion that winds the belt into a solid roll draws it through an attachment of knives and finishers which trim the edges true and give them a hard, smooth and handsome finish.

The Contrast. In Fig. 17, we give a good illustration of the belting ready for market as produced by the two methods we have described.



AUTOMATIC SPACING AND BORING MACHINE.

The above cut represents a very useful machine for boring the stiles to Rolling Blinds, and is used for that purpose exclusively. The machine carries two bits, and bores two stiles at the same time, at the rate of 6,000 holes per hour. It requires but little skill to operate it. The stiles, after being jointed, are placed upon the machine table with a ratchet or pattern between them, the ends of the stiles resting against two blocks securely fastened to the end of the pattern; and are moved over the bits by means of a pawl operating in the pattern notches. The spacing is regulated entirely by the notches in the pattern, and can be placed at any distance apart, from 1 to $1\frac{1}{8}$ inches, the spacing in the finished work agreeing with the notches in the pattern. The patterns are made of hard wood and of suitable length so that but one or two will be needed for all lengths of blinds.

The mortices are marked on the top edge of the stiles while the machine is in operation, from corresponding marks on the edge of a thin strip which has been previously tacked to the side of the pattern, and which can be replaced with any length required. The stiles and pattern should be clamped together (as represented in the small cut) before removing them from under the pressure roller so they may be inverted

upon the brackets (which are fastened under the table) while the mortices are marked on the face edge of the stile. The bits are brought up to the work by means of an eccentric pin and yoke on the back side of the crank wheel, the yoke being connected with the bit frame below and made adjustable so as to regulate the depth of the holes. By this peculiar arrangement the holes are of a uniform depth so that the pivot shall turn on the end and not on the shoulder of the slat. Manufactured by L. S. Colburn, Oberlin, Ohio.

NO SUPPLEMENTS.—In reply to a constantly repeated query, we beg to say that we issue no supplements. Originally, our journal was a monthly; instead of issuing supplements, we enlarged it from time to time; we then changed it to weekly, without increase of price; and we are constantly improving the quality and arrangement of the reading matter. By excluding a good deal of rubbish, and relegating purely advertising matter to the appropriate columns, we avoid, so far, the necessity for supplements, whether free or charged for. We prefer to concentrate our energies on one regular issue; and to put all our supplements *on our subscription books.*

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The Channel Tunnel.—The British Society of Engineers publishes the following details of the preliminary works for the tunnel under the channel. The year 1875 was profitably employed. The outlay amounted to 61,000 francs, the half of which, or 30,500 francs, had been expended in geological researches at the end of December, as shown in the report presented at the first general meeting on the 15th of March, 1875, by M. Lavalley. The result of the first year's labors is contained in fou reports, which were then distributed, and which describe the bases on which the studies are founded. This year the surveys have continued on a larger scale. In 1875, 1522 soundings were taken, of which 753 brought up specimens from the bottom of the sea. The engineers had at their service the Pearl, a small steam tug with insufficient appliances, and with which they worked between August 10 and September 21, during which time they could only leave the port of Boulogne twenty times. This year the soundings have been effected on the English side with a large vessel fitted with a crane and better provided. The work commenced at the beginning of July, and the vessel is stationed at Dover, which port it can enter or leave at all hours. Greater progress in the formation of the company has, however, been made in France than in England. The 2,000,000 francs required for the preliminary surveys have not yet been raised.

Continuous Brakes in England.—The use of continuous brakes on the railways of England is not as general as in this country. This is owing partly to the fact that the Royal Commission, appointed to make experiments with the best brake, has not yet reported, although the experiments were enacted about eighteen months ago. The London & Northwestern Co. have adopted the Clark patent improved by Mr. F. W. Webb. This appears to be an inferior instrument to the Westinghouse automatic brake. The Midland Company early adopted the Westinghouse brake, substituting for it later the improved automatic brake of the same inventor, and this brake appears to be decidedly the most satisfactory. There are fifty locomotives fitted up with it on the Midland road, and the experiments of the Royal Commission above alluded to were largely made with it. These two great companies are the only ones that have, up to the present time, adopted continuous brakes, although their importance in preventing accidents with trains at high rates of speed has been completely demonstrated. The Great Western road, and all the railways south of the Thames, are still operated by the old brake system, wherein the locomotive whistle sounds the order to put on the brakes to the guardsmen, who perform the functions of the now almost obsolete brakesman on passenger cars in the United States. * * * * *

Engineering, in discussing this question, presents some very forcible arguments for the adoption of brakes to be applied by the engineeer. We quote the following :

"A train weighing 200 tons, and moving at the rate of 60 miles per hour, has stored up in it an energy of 24,050 foot-tons, or in other words, it is capable of striking a blow equal to that which would be exerted by a weight 24,050 tons falling one foot, or by the whole weight of the train falling 120¼ feet. Let us us now imagine this train to fitted with a continuous brake capable, when fully applied, of exerting a retarding force equal to 17½ per cent. of the weight of the train (an amount well within than that obtainable in all ordinary states of the rails) and let us consider what might happen if an obstacle was suddenly discovered on the line 800 feet ahead. In the first place a delay of but nine seconds would cause the brake to be applied only eight feet before reaching the obstacle, and the latter would thus be struck by the train with its full force, and with the results which may be imagined. With a delay of six seconds the train would strike the obstacle with a force of 14,530 foot tons, equivalent to dropping the train 72½ feet, while with a delay of three seconds the measure of the blow would be 5,790 foot tons, or equivalent to dropping the train 29 feet. Again, with a delay of two seconds the striking force would be 2,210 tons, or equal to dropping the train about 11 feet, while if the delay is one second only, the train would be brought to a stand in 775 feet, and thus clear the obstacle and with 25 feet to spare. At a speed of sixty miles per hour every second's delay on the application of the brakes means that the train will run eighty-eight feet further than it would have done had there been no loss of time, and it needs very little experience in railway accidents to learn the value of these eighty-eight feet distances." [*Railway Review*, xiii, 145.]

The Railway Bridge Over the River Tyne.—An iron bridge of peculiar construction was inspected on Friday, October 6th, by Col. Hutchinson, R. E., the inspector appointed by the Board of Trade.

The bridge is at a picturesque bend in the river Tyne, about nine miles west of Newcastle, and forms a portion of the Scottswood, Newburn and Wylam Railway, carrying it over the river to a junction with the Carlisle branch of the Northeastern Railway.

The structure consists of a wrought iron arch 240 feet span and a forty-eight feet rise, formed of three parallel latticed ribs, to which the railway platform is suspended by vertical suspension bars at intervals of 12 feet. The upper portions of the ribs, above the height required for the passage of trains, are well braced together with vertical and diagonal bracing. The whole structure consists of wrought iron, and presents a light and elegant appearance.

The testing of the bridge occupied a considerable time, the load applied being locomotives of the heaviest description, which were successively brought on to the bridge until the whole platform was covered, six locomotives, weighing 333 tons, being required for that purpose. The greatest deflection was obtained when both roads were loaded with three locomotives in the center of each, when the center rib deflected less than one and a quarter inches and the outer ribs one inch each. When one side of the bridge was loaded with six locomotives, the deflections were less, viz., the center rib nearly one-half inch and the outer rib nearly three-quarters of an inch, the rib on the unloaded side showing no movement, and these results were also obtained when the six locomotives were transferred to the other road. It will be seen that owing to the more uniform distribution of the strains the deflections were less with six locomotives than when three only were on the bridge. The running of six engines coupled over the bridge at speed produced no greater deflection, and no perceptible lateral vibration, the ribs being perfectly steady under this trying test; as also under the concluding one of running three engines from some distance beyond each end of the bridge and stopping them as suddenly as possible in the center of the span opposite to each other. Many other tests were applied, but all with the same result, viz., to show small deflections and great steadiness under a rolling load.

The conclusions to be drawn from these tests seem to be greatly in favor of the arched form for utilising to the utmost the strength of wrought iron, the total weight of iron in the bridge being only 282 tons for two lines of rails. The bridge was designed by Messrs. George & H. Laws, of Newcastle-on-Tyne, the engineers of the railway, and erected by Messrs. Hawks, Crawshay & Sons, of Gateshead. [*Herapath.*]

The Soundings taken in the British Channel at the expense of the Submarine Railway Company with the steamer Ajax, have been completed. Not less than 3,257 specimens have been collected, and will be classified for the purpose of compiling a chart of the sea-bottom. On the 18th inst. the shaft at Sangatte had reached the depth of 122 metres ; the boring, it is expected, will reach its termination, 130 metres, by the end of the month. [*Nature*, xiv, 581.]

MINING, METALLURGYAND MINERALOGY.

Experiments with Temper in Steel.—Prof. A. S. Kimball, of the Worcester Institute of industrial Science, writes to the *American Journal of Science and Arts* "On Some Changes in the Physical Properties of Steel Produced by Tempering." The following will be interesting to all iron workers : A few interesting and, to a certain extent, novel results, have recently been developed in our laboratory, which I venture to present in their present incomplete form, since the pressure of other duties will postpone, for a few months, futher investigation in this direction. Up to the present time the larger number of our experiments have been made upon the behavior of tempered bars under a transverse stress, although a few qualitative trials have been made upon changes in electric conductivity and co-efficients of expansion.

1. "The modulus of elasticity decreases as the hardness of the steel increases ; in other words, the harder the bar the greater the deflection produced by a given weight." Many manuals of practical mechanics give a higher modulus for tempered than for untempered steel. Reuleaux, in "*Der Constructeur* (p. 4), states that it may be increased 50 per cent. by hardening. Coulomb and Tredgold state that a hardening has no influence whatever, while Styffe finds that the modulus is diminished. For our first experiment, five pieces of good tool steel, each 13 inches long, were cut from a half inch square bar. These were carefully annealed, squared and polished. No. 1 was laid aside, and the others were hardened in cold water in the usual manner; No. 2 was "drawn" on a hot plate to a dark blue ; No. 3 to a purple ; No. 4 to a straw color ; No. 5 was left hard. The modulus of elasticity was then determined by measuring the deflection produced by a weight applied to the middle of the bar. The probable error of the experiments did not exceed one fifth of one per cent. The experiment was varied in many ways ; several qualities of steel and bars of different dimensions were employed, with uniform results. In some grades of steel a difference of more than 10 per cent. has been found between the modulus of the hardened and that of annealed bar.

2. "The increase of deflection in a given time is greater the harder the steel." It is well known that the deflection of a bar left under stress will increase for a long time. I am not aware, however, that comparative tests of the rate of increase in steel of different tempers have previously been made.

3. "The immediate set increases with the hardness of the steel. ' In the experiments each bar was of course loaded with the same weight, which was allowed to act for the same number of minutes.

4. "A bar recovers from a temporary set with greater rapidity the harder it is." The remarkable fluctuations in the line of the bar observed by Prof. Norton, became more marked and had a wider range as the hardness of the bar increased.

Russia Iron.—Baron de Wagstaff, a heavy manufacturer of Russia sheet iron, and now on a visit to this country, emphatically denies the widely accredited reports that the secret of the manufacture of this iron is possesed solely by the Russian government, or that it is guarded with rigorous jealousy. He states that four-fifths of the polished sheet iron made in Russia are manufactured at private works ; and whilst it is true that all efforts heretofore made in this country to produce an article equal to theirs have failed, nevertheless there is no chemical or other like secret connected with its manufacture; nor is there any peculiarity in Russian ore that gives them the power to maintain their superiority, for at the many private works where these sheets are produced various ores are used. The whole "secret" is in the mode of manipulating the iron at a certain stage of the manufacture, which has been invariably overlooked by those who have attempted it in this or any other countries. While withholding a description of this manipulation, he states that no success will ever attend the efforts to manufacture from cold-pigs or puddle blooms, that any trace of sulphur or phosphorus in the iron is fatal to good result; and he adds that he should experience no difficulty in producing the very finest Russian sheet iron at existing works in many parts of the United States. Cannot some of our analytical metallurgists solve this important secret? [*Sci. Press*, xxxiii, 315.]

"The Secret of Russia Iron."—In an article in last weeks' *Bulletin* it was stated Baron de Wagstaff, a heavy manufacturer of Russia sheet iron. and now on a visit to this country, emphatically denies the widely accredited report that the secret of the manufacture of this iron is possessed solely by the Russian Goverment, or that it is guarded with rigorous jealousy. The Baron, however, has made no statement of the manner in which this iron is manufactured. A correspondent informs us that a writer of the name of Ehrmans, who traveller in Siberia in 1827, and who gave a large share of his attention to metallurgy during his travels, says, in speaking of the manner of making of iron in the Ural iron district, that the making of iron plates is carried to great perfection. The rollers used are not formed by the lathe, but cast at once with the requisite smoothness and regularity in iron moulds rubbed over with graphite. While the plates are undergoing the operation of rolling out, particular care is taken that the edges be kept free from gaps by paring them with large shears.

They are then placed in layers of ten or twenty, on an ingeniously contrived movable bench, which passes them to and fro under a hammer of forty *poods* weight, by which both sides are alternately exposed to its action, while a man carefully brushes off the scales that are continually produced on the surface. This doubtless is the process by which the celebrated Russia iron is made.

Ehrmans further remarks that these black iron sheets have been applied to the manufacture of a great variety of utensils, beside being used in covering the roofs of houses, as the excellent quality of the metal enables it to assume any degree of tenuity. It may be observed that the ores of the Ural district where this iron is made are magnetic oxides, the same as are found in the Lake Superior region, and occur in mountain-like masses as they do there. [*Com. Bulletin.*]

A Large and Very Rich Deposit of Copper Ore has lately been discovered in the southwest arm of Notre Dame Bay, Newfoundland, at no great distance from Bett's cove mine. The vein has been traced for one hundred and forty feet, and widens as it descends. The samples taken from it contain 12 per cent. of pure copper. Mining operations will be commenced at once, as there is no want of capital. Another valuable deposit is also reported to have been found at Rogue's Harbor, and a lead mine in Fortune Bay. These and subsequent discoveries give every indication that Newfoundland is destined to take a prominent place among the mining regions on this side of the Atlantic. An important fact is that all these discoveries have been made along the shore,

the interior being yet untouched. It is expected that not less than $800,000 worth of copper ore will be exported this year. Labor is in great demand in the mining region, and many fisherman of late are abandoning the shore fishery, which was unsuccessful, and applying for employment at the mines. [*Iron Age*, Nov. 16, 1.]

CHEMISTRY, PHYSICS AND TECHNOLOGY

Powder-Paper.—A substitute for gunpowder has been invented in England, called "powder-paper," viz., paper impregnated with a mixture of potassic chlorate, nitrate, prussiate, and chromate, powdered wood-charcoal, and a little starch. The powder-paper is rolled into the shape of a cartridge of any required length or diameter. The manufacture involves no danger, it is said; no explosion can take place except by way of contact with fire. The powder-paper leaves no greasy residue on the inside of the gun; it also produces less smoke, gives a less violent recoil, and is less impaired by humidity than gunpowder. With equal charges, by weight, of gunpowder and powder-paper, the penetrating power of the latter is 5-16ths greater than that of the former. [*Pop. Sci. Monthly*, x, p. 253.]

The Solvent Powers of Glycerin.—According to Klever, one hundred parts of glycerin will dissolve:

	Parts.		Parts.
Acid, Arsenious	20.00	Mercury Bichloride	7.50
" Arsenic	20.00	" Bicyanide	27.00
" Benzoic	10 to 20.00	" Arseniate	50.00
" Boracic	10.00	Potassa Chlorate	3.50
" Oxalic	15.00	" & Iron Tartrate	8.00
" Tannic	50.00	Potassium Bromide	25.00
Alum	40.00	" Cyanide	32.00
Ammonia Carb	20.00	" Iodide	40.00
" Muriate	20.00	Morphia	0.45
Antimony Tartrate	5.50	" Acetate	20.00
Atropia	3.00	" Muriate	20.00
" Sulphate	33.00	Soda Arseniate	50.00
Barium Chloride	10.00	" Bicarb	8.00
Borax	60.00	" Carbonate	98.00
Brucia	2.25	Phosphorus	0.20
Cinchonia	0.50	Sulphur	0.10
" Sulphate	6.70	Strychnia	4.00
Copper Acetate	10.00	" Nitrate	0.25
" Sulphate	30.00	" Sulphate	22.40
Iron Lactate	16.00	Veratria	1.00
" Sulphate	25.00	Zinc Chloride	50.00
Iodine	1.90	" Iodide	40.00
Lead Acetate	20.00	" Sulphate	35.00

Glycerin is particularly valuable as a solvent for gum arabic, as also in paste. Glue, by continued digestion, is soluble in glycerin, gelatinizing on cooling. Glycerin dissolves aniline violet, alizarin, and alcoholic madder extract. A solution of aniline colors in glycerin is often used for stamping with rubber hand-stamps. Glycerin is employed to extract the perfume from flowers, and the aromatic principle of red peppers. Sulphate of quinine dissolves in ten parts of glycerin when hot, but when cold separates in clots, which, when triturated with the supernatant liquid, gives it the consistence of a cerate, very useful for frictions and embrocations. Fifty parts of warm glycerin will hold in solution when cold, one part of salicylic acid. Three hundred parts of water may be added without causing precipitation. [*Druggists' Adv.*, ii, 26.]

Tempered Glass.—"The Val-St. Lambert Glass Factory has been granted the monopoly of the manufacture of the De la Bastiè glass, in Belgium. Mons. de la Bastié has published his conclusions drawn from tests to which the tempered glass has been submitted in its diverse forms; the proofs are numerous and perfectly conclusive in favor of the tempered glass. This material is *not* "*unbreakable*," as those who first aided M. de la Bastié have wrongly stated; and the latter has not ceased to protest against this appellation; but it possesses a resistance to blows, and to the action of temperature, incomparably greater than ordinary glass. German *savants* and practical men, who have received from the general assembly of "Outre Rhin" glass workers, a commission to examine the discovery, have calculated the resistance of the tempered glass to be 50 times that of ordinary glass. This new product is destined to a grand future; the manufacture of lamp chimneys alone would assure an immense market." [*Moniteur Industriel Belge*, iii, 481.]

[Notice an item on the curious behaviour of tempered glass, in this journal, vol. ii, p. 142.]

New Alloy.—An alloy as beautifully white as electro-plate, and at the same time free from expensive nickel, is produced by strongly heating (two to two and a-half hours of brightest red heat) a mixture of one part of best manganese ore in powder, one part of powdered copper scales, with two parts of bone-black. After the lapse of that time, the crucible (a graphite crucible to be preferred) is left to cool, and turned over, when a beautifully white button falls out, along with the unburnt bone-black. This metal may be filed, rolled, and drawn, has a beautiful sound, and seems destined to compete sensibly with nickel and German silver. [J. J. Hess, in *Der Metallarbeiter*, through *Pract. Mag.*]

Artificial Petroleum.—The origin of the enormous store of gas buried in the interior of the earth has not yet been fairly elucidated. Recent experiments presented to the Académie des Sciences by M. Byasson open the path to knowledge of the reactions which cause its production.

We know, in a general way, that mineral oils are the result of large distillations of ancient or present date, produced in the depth of carboniferous strata. But we are ignorant of how this result is produced, and all attempts, until now, to form petroleum have utterly failed.

M. Byasson, by projecting on a red hot iron plate a mixture of carbonic acid and water-steam, has succeeded in determining their combination; he thus produced more than 100 grammes (3.52 oz.) of a mineral essence possessing all the properties of petroleum.

This remarkable experiment, whilst explaining one of the mysterious phenomena of geology, opens for scholars a vast field of experiments by pointing out a new method of manufacturing carburets of hydrogen. [*Revue Industrielle*, Aug. 23, 1876, through *Pract. Mag.*]

On the Ignition and Explosion of Flour Dust.—Oscar Oexle.—Bran and flour dust when mixed in certain proportions with air form an explosive mixture. The author considers the use of an open light quite as dangerous in mills as in mines. The reason that so few explosions have really taken place is because either too much or too little dust was present. [*Polyt. Notiz-blatt, through Am. Chem.* vii, 75.]

Copying Ink from Extract of Campechy Wood.—About 250 grms. of the commercial extract is broken up and placed in 3 kilos. of distilled water for one or two weeks. It is then carefully decanted, and 20 grains acetate of maganese added. A solution of acetate of iron is dropped slowly in until an intense violet blue color is obtained. It should be thickened with dextrine or sugar rather than with gum arabic. [*Polyt. Notiz-blatt, through Am. Chem.* vii, 75.]

On the Reasons for the Floating of Solid upon Molten Iron.—Discussions in the *Niederrheinischer Bezirksverein.*—The following were suggested: 1. That the motion of the molten mass was such as to keep a solid body on the surface. 2. That some gas as CO, or air, formed a layer over the surface of the solid iron in such a way as to make it specifically lighter. 3. That the density of molten iron has not been as accurately determined as is necessary for a perfect understanding of the question. [*Ztsch. des Vereins D. Ingen.*]

Spontaneous Combustion of Silk.—Some weighted silks, which were insured, having while stored developed heat enough to ruin the goods, though no flame appeared, the insurance company refused to pay the insurance. The court decided that the silk was burned, and ordered payment. [*Reimann's Färberztg.*]

MISCELLANEOUS.

Cremation of the dead is now fairly established in Saxe-Gotha. In a recent sitting of the town council, it was decided to erect the necessary apparatus in the new cemetery. Cremation is to take place only in accordance with the clearly expressed wish of the deceased, and under permit from the proper medical officer. The ashes are to be gathered in urns, to be preserved by the family of the deceased, or set up in a hall in the cemetery. [*Pop. Sci. Monthly*, x, p. 255.]

The American Forestry Association.—The American Forestry Association held its first meeting at Philadelphia in September. Addresses were delivered by Dr. Franklin B. Hough, of Lowville, New York, Mr. McAfee, and Mr. Meehan. Dr. Hough gave an acconnt of the efforts made by various European governments to preserve forests and to promote timber-culture, and showed that the Constitution of the United States, and those of most of the States, give the right to interfere for the preservation of our forests. Mr. McAfee reported on the condition of forest culture in the West, showing how the planting of trees had been going on to an immense extent, and that it was found that the old notions about the slowness of timber-growth had been derived from the hard struggle with Nature that wild timber had to make. Cultivated trees had grown so much faster than was expected that people had been surprised at the growth, and it is now becoming generally known that wood came into profit much sooner than was thought possible years ago, and forest-culture was much more popular in consequence. In his state at least 80,000 acres of timber had been planted during the past few years, and the work was still going on. He gave figures as to the growth of individual species, chiefly from facts within his own observation. Mr. Meehan, from whose *Gardener's Monthly* we take this account of the meeting, thought that the people, without government interference, can be safely trusted with the care of our forests, and the work of re-forestation. Individual effort, encouraged by state laws and agricultural and horticultural societies, would soon replace the decaying forests of our land. [*Pop. Sci. Monthly*, x, p. 251.]

American Saw Mills for Germany.—The star of Empire is wending eastward now. The Lane Manufacturing Co., of Montpelier, Vt., received last week a cable dispatch from Zizenhausen, Baden, Germany, ordering a heavy double circular saw-mill; the saws to be 60 and 30 inches in size respectively. At the present time there are no American—in fact no really good—saw-mills any where in southern Germany—the Black Forests—and Switzerland. This purchase of a first-class American mill will not fail to make quite a revolution in the business over there. The Lane Manufacturing Company is to be congratulated upon being pioneers in this new-old field. With Roger's "nigger," Prescott's steam feed and the "boss dog" attached, the echoes of the Hartz mountains will be awakened by sounds more modern, if not more hideous than were invoked by the goblins of the Black Crook.

Portland Cement on Wood Work.—Portland cement has many uses in the garden and elsewhere, not generally apparent. Some of them are enumerated by the *Garden* as follows: When made into a thin solution like whitewash, this cement gives wood-work all the appearance of having been painted and sanded. Piles of stone may be set together with common mortar, and then the whole washed over with this cement, making it look like one immense block of gray sandstone. For temporary use, a flour barrel may have the hoops nailed, so as not to fly apart, and the inside washed with a thin paste of Portland cement, and it will serve for a year or more to hold water. Boards nailed together and washed with it make good hot water tanks; and it is of use in so many ways that it may be regarded as one of those peculiar things in a garden which it is always good to have at hand.

Exhibition of Heating Apparatus at Cassel.—A special exhibition, in which foreign manufacturers can take part, will be held this winter at Cassel, in the buildings of the new Industrial Museum. This exhibition will comprise apparatus for heating and ventilation of houses, studios, sick-chambers, etc. It will be divided into three sections:—

1. Models of large heating apparatus.
2. Apparatus designed specially for heating and ventilating apartments, and not included in the first section.
3. Heating apparatus for kitchens, and designed for industrial purposes; stoves for workmen's and rural habitations, such as cooking ovens of new design.

Combustibles of all kinds will be admitted. Application should be made to the Director of the Industrial Museum. Consignments of objects exhibited should be made at the expense of the exhibitors, and before November 15th. Prizes will be distributed at the close of the exhibition. Apparatus of new design will be tested by an Examining Committee. [*Mon. Ind. Belge*, iii, 492.]

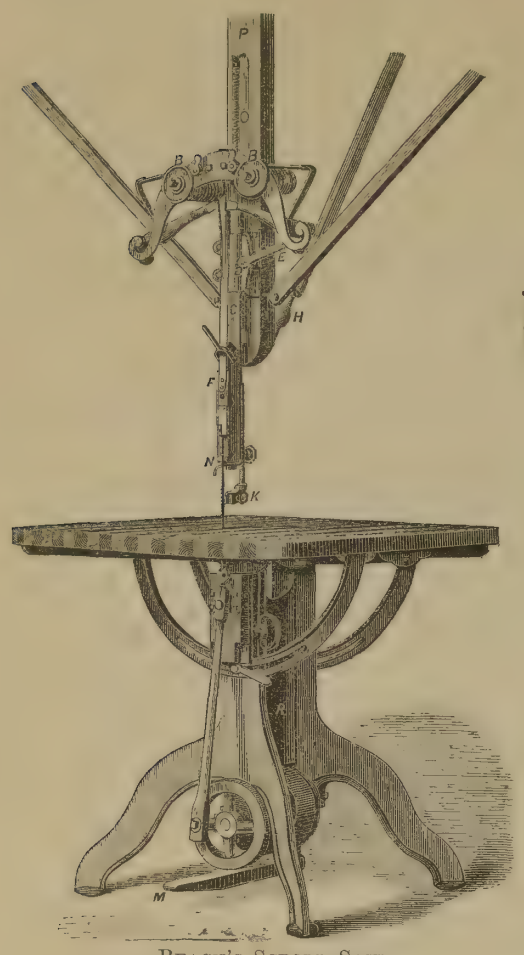
Exposition of 1878.—By royal decree of Oct. 20, Prince de Caraman Chimay, governor of the province of Hainaut, has been appointed president of the Commission which will be instituted, later on, to organize and direct the meeting of Belgian producers at the Universal Exposition of Paris, in 1878. The Italian, Austrian and Danish governments have designated their delegates.

Italy is represented by Commander Victor Ellena, director of commerce of the kingdom; and by Prof. Basile, architect, director of the construction of the Grand Theatre of Palermo. These delegates have had a long interview with the Commissioner General, and have stated to him the important part which Italy will take in the Exhibition; the government has already authorized, for this purpose, an expenditure of 3,000,000*f.* The Austrian delegate is Dr. Walcher de Moltheim, counsellor of the imperial-royal ministry, and adjunct consul-general of Austria and Hungary. He will exercise the functions of provisory commissioner delegate.

For Denmark, choice is made of Mr. Frederic Wolfhagen, formerly minister, and chamberlain to the King of Denmark. [*Moniteur Ind. Belge*, iii, 481.

Church Ventilation.—One of our evening dailies has this: A down-town church, recently frescoed, rejoices in the possession of some elaborately executed scriptural mottoes on its walls. One of these, quoted from Jacob's exclamation at Bethel, reads: "This is the house of God. How dreadful is this place." Considering the fact that there is a total absence of ventilation, and a great many of the tenement house population worship at this church, the Scriptures could hardly furnish a more appropriate motto than, "How dreadful is this place." It is a dreadful shame for people to be untidy in their persons, or to go unwashed to the house of the Lord; and it is a dreadful piece of carelessness for a building committee to make a church so much like a packing box that the foulness thus communicated to the air cannot get out of doors. They seem to be afraid to turn that bad air out of doors, probably for fear it will pollute the neighborhood. So the sexton locks it in by shutting all the doors and windows as soon as the congregation departs.

CENTENNIAL NOTES.

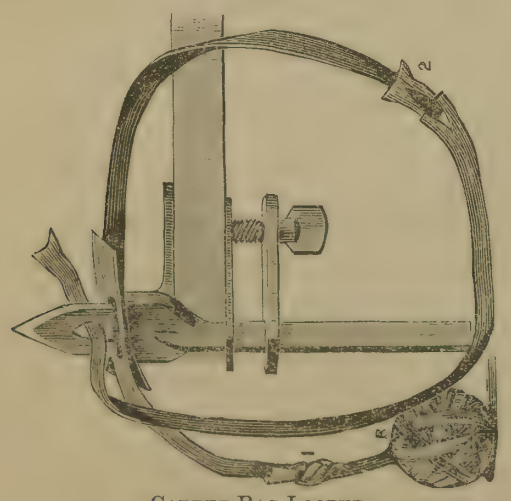


BEACH'S SCROLL SAW.

H. L. Beach, of Montrose, Penna., showed an excellent scroll saw. Both the upper and the lower guide-ways have a lateral motion either way, to line the saw; both the cross heads are adjustable for wear. The table bed is fastened to a cast-iron plate, which prevents warping or rolling. This plate is so secured to the lower frame that it can instantly be thrown at any angle, allowing the saw to cut almost any bevel. The crank-shaft carries a friction-pulley adjustable for wear, so that starting and stopping are effected without belt-shifting.

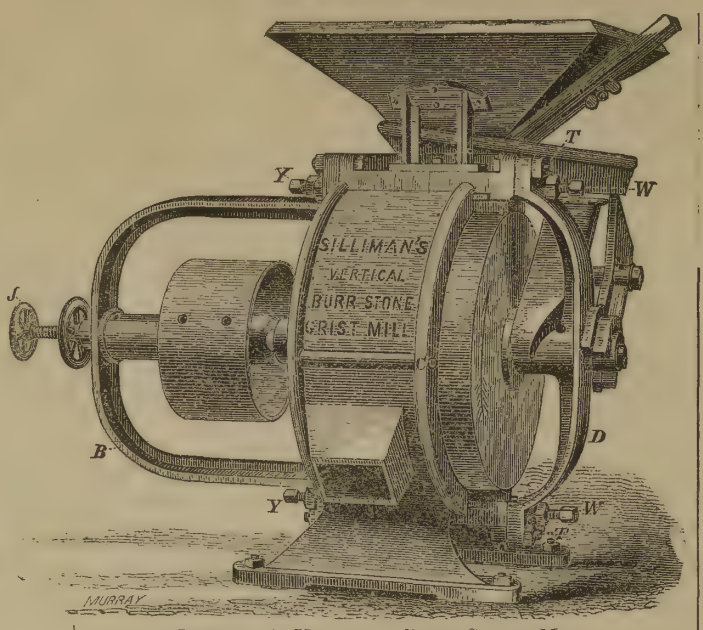
By a slight pressure of the foot upon the lever M, the saw is given any motion from 100 to 850 strokes. Each of the springs, AA, contains 6 ft. of ½-inch steel, and has a force of 100 lbs. While the saw moves 5¼″, the average motion of he springs is but 1-12″. By means of the ratchets, BB, the saw may be given any desired strain, which will be even at all parts of the stroke. The upright tubular wrought iron shaft, C, is turned true outside and in, and to it are attached all working parts above the table; it is held in place by the box, D, and eccentric lever, E. By raising the last, the shaft, C, is released; and as it is balanced by the spring, O, is free to move up or down to suit the saw lengths.

The blast-pump is a part of the cross-head, F, and is placed inside of the shaft, C. The steel-bearing, K, is a support for the back of the saw-blade, and a step for holding down the work, and is adjustable vertically to suit the thickness of the stuff. The lower saw-blade end is held by a clamp.



CARPET RAG LOOPER.

This device is a trifle, but may interest the wives of some of our readers. The cut shows very clearly its mode of operation—forming, by piercing and looping, a much better junction than effected by sewing. It is made by Naylor and Jeffries, 864 West St., Philadelphia.



LEONARD'S VERTICAL BURR STONE MILL.

[Made by Leonard & Silliman, Bridgeport, Conn.]

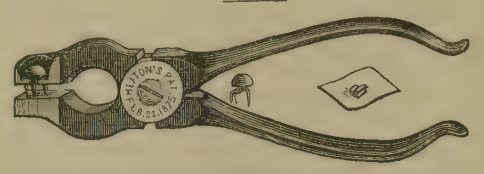
The makers of this mill make the following claims as to its merits:

"It is unlike any other vertical mill in the following important particulars: The frame is so proportioned and constructed as not to have any strain whatever from shrinkage of the castings or any other cause; all the pressure of grinding is received by a very strong vertical section of the mill, thus securing the greatest possible strength with the least necessary weight; although made wholly of metal and stone, we warrant them not liable to break from pieces of iron or other hard substances passing through them; this result never before secured, is the combined effect of the proportions and strength as above, together with that of the spring arched casting B, and a vibration of the bed stone.

It has an extra length of spindle in proportion to the diameter of the stone, with three extra long bearings, by which the greatest durability, and the least possible variation in the face of the runner stone is secured. The bed stone being hung on vertical journals, can never wear out of balance, but can always vibrate and conform to the runner. By the screws W W, and Y Y, it is easily adjusted to set it in face with the runner, or to set them together when worn. The runner stone being firmly secured to the spindle and not having to be taken off for dressing, is never thrown out of face.

Being provided with large openings for receiving and discharging the grist, it is never liable to choke or clog; the grain drops from the shoe directly into our radiating centrifugal feeder, which throws it evenly between the stones on all sides alike, above as well as below; thus for the first time obviating a vital objection to all vertical mills. In taking the mill apart to dress the stones, the foundation bolts are never disturbed, and as each stone is taken out separately, the miller can easily do it alone, not requiring extra help, no crane and screw, or any special attachments to the mill at extra cost, but they are easily taken away on a simple bench or block. As shown by the cut, it is so constructed that it may be belted to, from almost any direction; above, below, or at either side as most convenient."

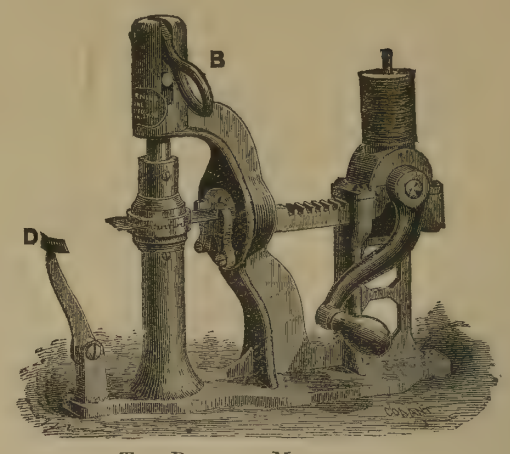
The mill is shown in Machinery Hall, Column E–56.



BUTTON FASTENER.

This little trifle does away with such a very annoying circumstance—the bursting off of shoe and other shank buttons—and effects its work so quickly and strongly, that it is given a place here. The cut explains itself. The makers are the Heaton Button Fastener Co., Providence, R. I.

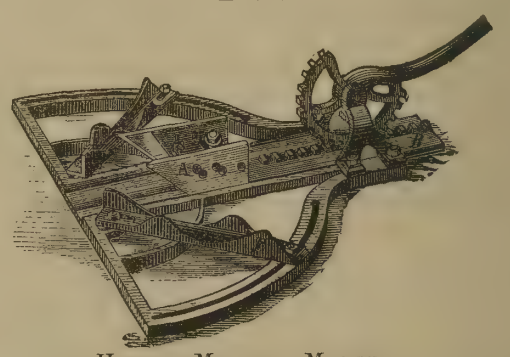
Fast Cutting.—At a competitive trial of saws at the Centennial saw mill, a 56-inch circular saw, made by E. Andrews, Williamsport, Pa., was, as is claimed, run on the extraordinary feed of 10½ inches, cutting a true and smooth board, 12 inches by 16 feet, in less than two seconds. The trial was had on a Stearn's Manufacturing Company's mill. The saw was put in order and run by H. Fairbrother. The maker states that all other saws failed to work on the above feed.



THE DARNING MACHINE.

This neat little device (made by the Pope Manufacturing Co., Boston) is exhibited in Machinery Hall. The rack seen in the cut carries fourteen hooked needles, and is given forward or backward motion by a pinion and the crank shown. These needles pass through grooves cut transversely with the corrugations shown in the top of pillar or lower standard and in the bottom of a corresponding shoe, raised or lowered by the cam shown. Supposing the rack and needles to be thrown back to the right, and the shoe to be raised by the cam, the piece of goods to be darned is placed on the transversely corrugated top of the standard; the shoe is pressed down and gives corrugation to the thin goods surrounding the hole or weak spot in the fabric. The rack is then thrown forward, the needles thus penetrating the goods. A thread from the spool shown is then passed fourteen times between the needle-hooks and the teeth of the little comb or thread-holder shown at the extreme left of the cut. Withdrawing the rack and needles, the goods will be traversed by fourteen threads, in exact imitation of hand darning; the corrugations mentioned causing the needles to go alternately above and below the fabric as it lies normally. Turning the goods one-fourth way round, and pressing the half-darned spot into the corrugations, the operation is repeated—finishing the darn by re-traversing the spot with fourteen threads that cross alternately above and below the first set—thus weaving a new fabric. This "cast-iron grandmother" is both curious and practical; and should prove of service in large households.

G.



HOWARD MITERING MACHINE.

The cut shows the Howard Mitering Machine described in one of our earliest Centennial issues; and a very powerful and clean cutting adjustable little machine. Shown in aisle A, Machinery Hall.

—The river Amazon is navigable by vessels of large size for a distance of 3000 miles. Two thousand miles from its mouth its channel has a depth of three fathoms; and for 2600 miles there occurs no fall to interfere with the smooth passage of shipping. The river has four contributaries, each over 1000 miles in length, which are united by a network of natural canals, thereby increasing the facility for intercommunication.

—The system of sawing down trees, instead of chopping, will be more generally followed by our lumbermen in the future. It is claimed that three men thus employed will perform four men's work, and that hands can be procured for less wages, as sawyers, thereby getting rid of the high prices that first-class choppers have heretofore realized. [*Lumberman's Gazette*, viii, 325.]

—Our hemisphere comprises some 8,960,000,000 acres. Now, allowing one tree to the acre, and 1,500 feet to the tree, we have 13,440,000,000,000 feet, or thereabouts, for this continent alone. This added to the supply on the antipodes will give the reader a very fair idea of the world's timber supply; and here you have it in a nut-shell! Now, let us hear from the man in the moon. [*Lumb. Gazette*, viii, 326.]

THE

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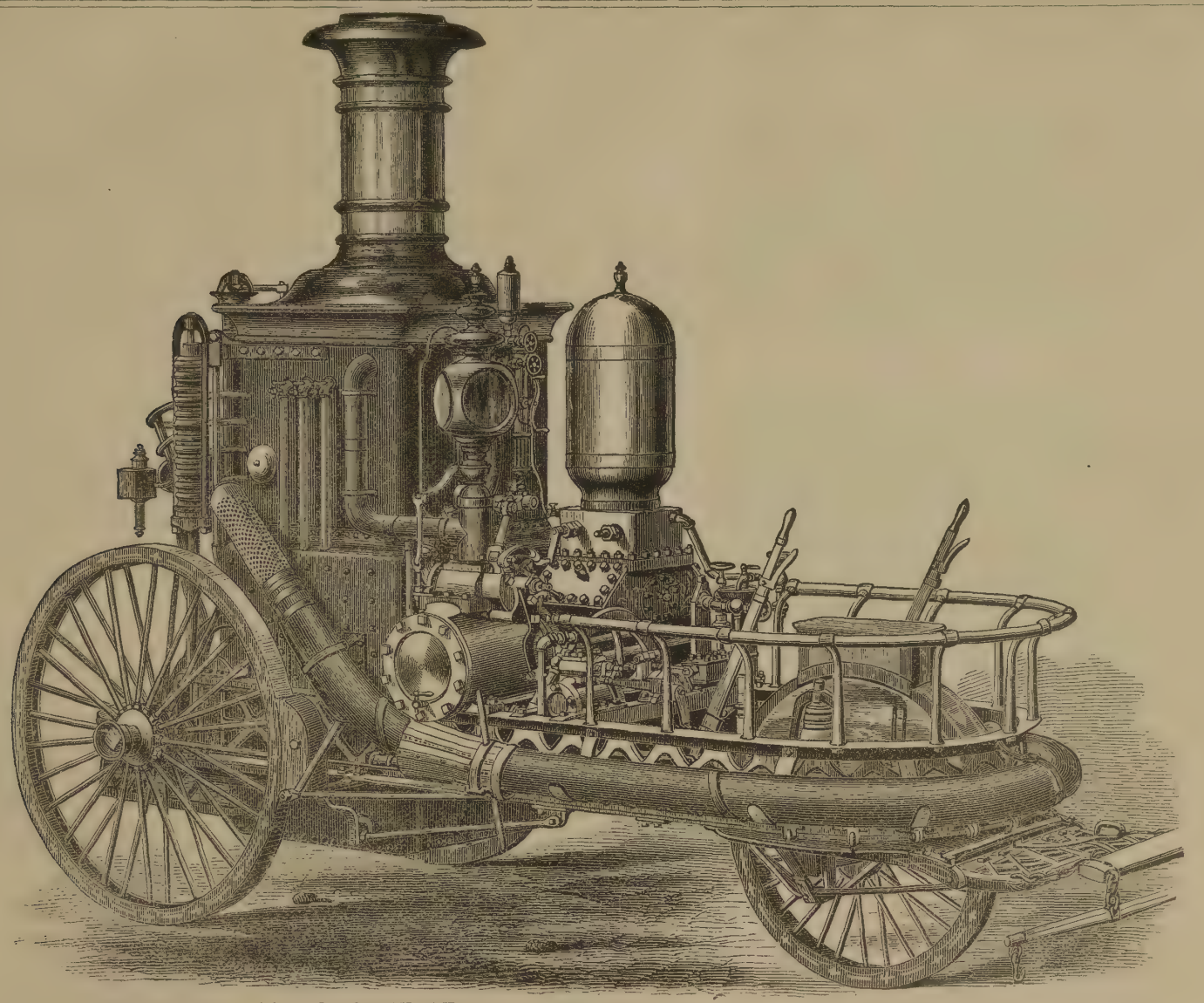
VOL. II. PHILADELPHIA, DECEMBER 2. 1876. NO. 22.



C. AHRENS & CO., 24 and 26 WEBSTER ST., CINCINNATI, O.—1st and 2d CLASS LATTA BOILERS.

MODERN FIRE ENGINES.

X.

In 1855, Abel Shawk, of Cincinnati, built a steamer with a boiler having a fire-box 3½ by 4½ feet high, with arched top, and containing a continuous series of small horizontal parallel tubes; in connection with this was a horizontal cylinder 10 by 2½ feet, placed near the ground, and unequally divided by a vertical transverse diaphragm. In the larger part near the upright case was another continuous series of small tubes, the space around them being connected with the end of the first named series of tubes; the other end of this first series and one end of the second series were in connection with the force-pump. On lighting the fire, the first series of tubes became heated, the water being injected was converted into steam, and entering the cylindrical case heated the water so injected, or ran over into the second series, converting it into steam, and thus supplying the engines.

The farthest end of the cylindrical case received the water from the pump, which had one suction inlet and eight hose gates.

The steam cylinder, 11⅜ by 25 inches, was placed horizontally on this case and next the boiler, having the pump, 7⅜ by 25 inches, in front and directly connected with it. The piston-rod had a 3-armed cross-head, the two lower ones working the feed pumps placed on the sides of the steam cylinder, and the top one working a small valve which admitted steam on either end of a small cylinder, to the piston-rod of which was affixed the main steam valve—thus allowing the main piston to complete its stroke before reversing. [See *Jour. Franklin Inst.*, 1855.]

In 1858, Poole & Hunt, of Baltimore, commenced building. Their boilers were upright multitubular, with square fire-box and enlarged steam space. Their pumps consisted of two horizontal barrels, one over the other; in each being two pistons, on one rod, and fitted with rubber valves. The two pump rods were attached to a cross-head, which was again attached to the steam piston-rod, so that one steam cylinder and piston worked the two pumps and four pistons—a small fly-wheel being used. Their 2d class engine had one cylinder 11 by 12 inches, double pump; each barrel 4½ by 12 inches; suction opening 4½-inches diam.; the boiler having 239½ square feet of heating surface.

Ettenger & Edmond, of Richmond, Va., commenced building in 1859. Their engines had vertical boilers, with 165 iron tubes 1½ inch diameter; steam cylinders 9 by 15 inches; two horizontal pumps each 3½ by 15 inches (equal to one 5-inch pump). Each pump rod was attached to a cross-head.

Mr. Joseph Parry built the first steam fire engine in Philadelphia, at Reanie & Neafie's. This engine was for the Philadelphia Hose; and we have before us a circular dated July, 1857, calling for subscriptions to the amount of $3,500 to build this engine from plans on exhibition at Mr. Sherrerd's office, No. 8 Merchants' Exchange. The drawings for this engine were made May 1, 1857; and the engine was completed and delivered in 1858. This was a "first-class" engine, weighing 9,000 lbs. The boiler was upright, 30 inches diam., with 187 iron tubes, each 40 inches long and 1¼ inch internal diam.; square fire-box, cold feed; the hind axle "cranked" 10 inches. The pump was 6 inches diam.; steam cylinder 12 inches diam.; stroke 14 inches; yoke motion. The frame was cylindrical and 18 inches diameter. The other engines built by Mr. Parry at Reanie & Neafie's are here specified in the order built. 2—"Alpha," for Baltimore. This was a twin to the first. 3—Hope Hose; 2d class, weighing 6,000 lbs.; same style as first; cylinders 8 and 4½ by 12 inches; 122 iron tubes 38 inches long. 4—Hibernia. 1st class; cylinders 11½ and 6½ by 14 inches; the pump cylinder afterwards enlarged to 7 inches. 5—Delaware. 1st class; same as Hibernia. 6—Vigilant, Baltimore; same as Hope Hose. 7—West Phila. Hose. Cylinders 9 and 5 by 12 inches. 8—Northern Liberties Hose; same as Hope Hose. 9—America Engine; same. 10—Good Intent; same. 11—General Clinch, Augusta, Ga.; same. 12—Mechanic Engine. 8 and 4½ by 16 inches; 122 tubes 38 inches long. 13—Pioneer Engine, Providence, R. I. 9 and 5 by 12 inches. 14—For Madison, Ind.; same as Pioneer. 15—Decatur, Frankford; same as Hope Hose. 16—Good Will Hose; 9 and 4½ by 16 inches. 17—General Meigs, Washington; same as Hope Hose. 18—For Nashville. Tenn.; 8 and 4½ by 16 inches. 19—Northern Liberties' Hose; 9 and 5 by 12 inches (now at Gray's Ferry, U. S. Arsenal). 20—For St. Louis; same as Hope Hose. 21—Volunteer No. 1. New Orleans; same as Hope Hose. 22—Pennsylvania Engine, San Francisco, Cal; same as Hope Hose. 23—Newton St. John, Mobile, Ala.; same as Philadelphia Hose. 24—General Rucker, Washington; 7 and 4 by 10 inches; weight 5,000 lbs.; boiler 22 inches diam.; 125 tubes, each 36 inches long, 1⅞-inch outside diameter; wheels turned under frame. 25—Gen. Butler, Norfolk,

Va.; 9 and 5 by 12 inches. 26—Weber, Sacramento, Cal.; same as Hope Hose. 27—Wm. Penn Hose. 9 and 5 by 12. 28—Volunteer No. 1, New Orleans; 12 and 6 by 14 inches; 220 tubes, each 36 inches long, and 1½ inch outside diameter; slab frame. 29—Corn Planter, Franklin, Pa.; 3d class; same as General Rucker. 30—Washington, Lancaster, Pa.; 9 and 4½ by 12 inches; slab frame. 31—Louisiana No. 10, New Orleans; same as last. 32—Washington No. 20, New Orleans; same as last. 33—Jackson No. 18, New Orleans; same as last. 34—Irid Ferry No. 18, same as last. 35—Chalmett, 8 and 4 by 10 inches; slab frame; wheels turned under. 36—Pioneer of Hazleton, 8 and 4 by 10 inches; wheels turned under. 37—For St. Louis. Same as Washington of Lancaster. 38—La Atravida, Cuba; same as Pioneer of Hazleton. All had square grates; the 1st class had grates 30 inches square; 2d class, 28 inches, and 3d class, 22 inches. Mr. Parry also built of the same general style, four engines at Landell & Co's, and one at the Hydraulic Works. The The four named were the Northern Liberties Hose, Good Intent, Manayunk, and one for Akron, Ohio. All had cylinders 10 and 5 by 12 inches, and frames of four angle irons. The one at the Hydraulic Works was the Weccacoe of Camden, N. J., 3d class; cylinders 8 and 4 by 12 inches; and Mr. Parry's best small engine. This one, lifting her water, filled her pumps while running 325 strokes per minute; and with 110 lbs. of steam, played a 1⅛-stream 250 feet. G.

(To be continued.)

"TEN MINUTE" PAPERS.

By PROF. J. E. SWEET.

I.—BAD HABITS.

[At the weekly meetings of the Mechanical Engineering Association of Cornel] University it is the practice of Prof. Sweet to deliver a short address or read a paper on tools—processes or some subject relating to the mechanic arts. These papers he has placed at our disposal; and from them we shall occasionally make extracts. The following is from one of his ten minute papers on "BAD HABITS."]

Notice the man who oils the machinery, the one walking around so unconcernedly; it seems to matter but little to him which end of the can is up. If he does not get twice as much oil on the floor as on the journals the fault is not his. See that man bringing an armful of waste to wipe off his tools, when a small handful would have been sufficient. Some one drops a file; it is broken; the pieces are thrown into the scrap heap, but he don't seem to mind it much. But if on pay-day the master took a fifty-cent note, tore it in pieces, and threw them into the waste-paper basket, how would *he* like it? Jones has left his shaper working along by itself all day; he is happy; he has a self-acting job, and can stand or sit around as he likes. He don't care whether it is attended to or not; the slide or shaft gets dry and, as a consequence, cutting. The machine has to be taken apart, the surfaces scraped and cleaned; and by the time it is started again a quarter of a day is gone, the job delayed, the machine injured, money lost, and all for the want of a little of that oil that Smith wasted on the floor, and of that attention which Jones was paid for bestowing on the machine which, with a fair show, runs itself. Brown puts on a milling machine cutter back-handed and smashes all the teeth off in trying to make it cut.

This standing around when there is a chance is not due wholly to laziness, if in any great part, but grows out of the feeling, easily caught by apprentices, that "anything to beat the boss is all right." The man wastes the oil through indifference; the man who gets five times the amount of waste he needs, does so through the bad habit of taking all he can lay his hands on; the one who breaks his file, does so, through the bad habit of carelessness; Jones lets his shaper get cutting through the bad habit of shiftlessness; and Brown puts the cutter on backwards through the bad habit of working without thinking.

No workman who receives compensation for his services has a right to forget how to do that which he has been shown how to do once; no workman working for wages has a right to do anything without thinking about what he is doing, and to think out why or the reason for the way he does it. The habit of forgetting is a bad habit; working without thought is a bad habit; and bad habits in the use of tools are common. It is a bad habit to follow, this striking at a nail with a hammer and missing it; cushioning the blow on your thumb, not so particularly bad on account of the thumb, but it is a waste of blows. Striking at a chipping-chisel and missing it, allowing the mechanical energy stored up in the hammer to expend itself on your hand is not good policy, as it is a loss of time; and striking over the chisel so that the blow is received from the handle is not good practice, as that part of the handle "is not worth a cent" to drive chipping chisels; and besides, handles are limited in their endurance, and to keep up the repairs is costly. In forging, all the blows, of either hammer or sledge, that stop on the anvil do not perform useful work. Using the middle of the file only, when it is made to cut the whole length; using a new file to clean castings; and using a file to do rough work, are bad habits. Using a chisel, lathe or planer tool, or any tool that can be ground, dull, when there is a grindstone running near by, is not the best thing to do; and leaving your tools lying around anywhere, your machine uncleaned, the benches in confusion, is a shockingly bad habit. * * * * *

It is a bad habit to do anything without thinking *why* you do it that way. If told to do a thing in a certain way, do it as you are told; but, while doing it, think out *why* you do it in that way. If by the time you have it done you are not satisfied as to why it is done in that way, ask why. If you are given a job and *not* told how to do it, *think* out "how and why." There are usually two or more ways to do any piece of work; if one way is better than another there are good reasons to be found for it.

This bad habit of centering a piece and forgetting to see whether it was true, putting it in the lathe and forgetting to drill and countersink the centers, commencing to turn and forgetting to square up the ends, commencing to turn and forgetting to take into consideration whether the piece is large or small, iron or steel; forgetting to set your lathe running faster as your piece grows smaller; strapping a piece on the planer and forgetting to pack it up so as not to spring it, planing down the side and forgetting to turn the tool-post over side ways; trying to make a finished job and forgetting to file off the scale on the corners of a casting; cutting screws and forgetting to oil the dies; running your milling machine and forgetting to oil the cutters; drilling and forgetting to center the drill first; running your machinery all day and forgetting to clean and oil the slides and bearings;—all these things are every day reminders of forgetfulness, but still this is a habit less excusable than that of working without thinking. Another common specimen of bad habits is the screwing up of every bolt or nut as tight as it can be turned, whether it is necessary or not; when, by thinking what you are about, many times you would see that a single turn of the wrench was sufficient. If we would put a little less tension on our bolts and nuts, and a little more on our thinking and reasoning powers and memory, we would have fewer bad habits, and it would be better for us.

BRICK IN DECORATIVE STRUCTURE.

II.

We will give a description of the process of manufacture, as revived and improved by an enterprising Philadelphia company,* at its works on York Road, near Hunting Park.

The enamel itself may be described as something more than an opaque glass, than which it is much harder. While the Phœnicians are accredited with the invention of glass, we have proof of the manufacture and use of opaque enamels as early as the 4th Egyptian dynasty. At a very early date, the Babylonians and Assyrians had discovered that copper enabled them to produce an opaque blue enamel; and the use of tin to produce an opaque white enamel for bricks and vases, antedated by ages the re-discovery of the process, in Europe in the 15th century, and secured for Egypt and Phœnicia, during many centuries, a most valuable export trade with the other Mediterranean countries.

From the fall of the Roman Empire may be dated the disappearance of the secret, from the Arabic and Moorish races, which had retained a traditional knowledge of the art. The tin-enamel happily came into use again in Europe in the 15th, or as some say, in the 13th century; and enabled the production and perfection of that beautiful ware, majolica, so much sought after by connoisseurs, and the manufacture of which seemed for a time destined to become a lost art. But to our description of the modified process of enamelling as now practised very successfully in this city.

To produce the white enamel, there are taken certain (and not here indicated) proportions of China clay, flint, felspar, Paris white, boracic acid, and oxide of zinc; all thoroughly ground and intimately mixed. Where a blue color is desired, oxide of cobalt is added, Brandon mineral gives a drab, and uranium salt, a canary, etc. This frit is placed in "saggers" or shallow boxes of highly refractory material, lined, before each filling, with a thin coating of clay mortar. These saggers and their contents are subjected to a suitable kiln or oven to a heat of 2000° F., which fuses the frit and causes it to shrink about ⅓ in volume; forming dense blocks of enamel, which the previous lining of the saggers enables one to turn out without much difficulty. These blocks in size about 18×10×2½ inches and weighing about 50 lbs., are then broken by a powerful Blake crusher into chips about an inch in length; and these (which will cut ordinary window glass) are then finely ground between a horizontal bed-stone, and form revolving blocks or sections of burr. The resulting meal is next thoroughly searched with a magnet, to remove any fine particles of iron, cut by the enamel, from the iron jaws of the crusher. Were not these little particles thus removed, each would produce a stain or spot. The finely milled enamel is then mixed with water, to a creamy consistency; and into this mixture, dry hard burned bricks of good quality are carefully dipped, so that the brick absorbs the water and leaves the moist enamel powder evenly spread upon face, edge, or end, as is desired—the edge being the surface most commonly enameled; and each brick so treated requires about ¾ oz. of enamel—an ounce being allowed in order to account for waste.

Green (or unburned) bricks are not available for enameling, as they "blister" in the kiln. The dipped bricks having been thoroughly dried in racks, are next placed in saggers, five in each, resting upon strips of clay dough, and without touching each other. Each sagger has a clay luting placed upon its upper edge; and they are then piled in the kilns, one upon another, so that the bottom of each one, in connection with the clay luting, seals the mouth of the one below it.

The kilns are conical, with double walls, and up and down draft; have a diameter of 16′ 8″; and on the rule of "a ton to the foot," are granted 17 tons of coal for the burning. The kilns contain about 16,000 to 18,000 bricks, each; the burning occupies about 60 hours, and the temperature attained is about 2,000° F. The result of this process is that the enamel fuses itself into the surface of the brick; and adheres thereto, not as a scale which might be removed by mechanical means, but as a vitreous glaze, closing the pores, and presenting an even surface, which glass or ordinary steel will not scratch. It should be said that by a variation in the composition of the "frit," a "dead lustre" may be produced. The writer drove a tenpenny nail to the head in the framing of the drying room, using the enameled edge of a brick as the hammer face, and without making scratch or indentation on the enamel. A severer mechanical test need not be asked for.

As the enamel thus produced is in effect a porcelain surface, it should be highly resistant to powerful acid and alkaline solvents. It need scarcely be feared that the greatest ordinarily attainable variations in temperature, however sudden, could affect materials which had already undergone fusion and *fixation* at a temperature of 2000° F.; while they should endure the severest test ever given to building materials—intense heating in a conflagration, and sudden cooling by a strong jet of ice-cold water—far more satisfactorily than granite and other stones, which have so signally failed under these circumstances; and even better than good hard, but unenamelled, bricks.

The makers claim for the enamelled bricks greatly increased strength; a claim not yet tested by the writer.

To indicate the numerous, artistic and utilitarian applications of enamelled bricks, is not within the scope of this article. It is rather within our province to recount the many excellent qualities of this material; and after having pointed out its marked resistance to destructive and unhealthful agents of all kinds which have heretofore found more or less ready victims in other materials, to leave to the architect and the technologist the pleasant and profitable task of adapting this excellent material to their tastes, opportunities, and necessities. G.

* The Brick Enamelling Co., of Phila.; Office 309 Walnut St.

The Polytechnic Review:

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WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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SAWS AND SAWING.

BY JOSHUA ROSE.

The difficulties experienced in the use of saws arise from, first, their necessary weakness in proportion to their duty; secondly, the difficulty of disposing sufficiently rapidly of their cuttings, the saw-dust; thirdly, from peculiarities and variations in the nature of wood; fourthly, from the skill required to keep them in proper working order; and fifthly, from the impracticability of tempering them as hard as they should be, if the temper bore the same relation to the material cut, as is the case with most other wood-cutting tools.

The desirability of using thin saws, in order to lose as little timber as possible by keeping the kerf narrow, added to the distance at which the cutting edges of the teeth operate from the end of the saw, in frame saws, and from the center in circular saws, or in other words, the distance of the cutting points from their driving point, renders the blades very liable to spring; and thus involves a whole train of evils. If the spring was at all times equal in amount, and in one direction, it would be no difficult matter to so shape the teeth as to counteract it; but such is not the case. For in addition to the angles of the teeth, their relative keenness, added to inequalities in the wood itself, form constantly disturbing elements; and it is to suit these varying conditions that the shape of the teeth must be conformed.

Saw teeth may be divided into three classes: cutting teeth, sawing teeth, and intermediates. Cutting teeth perform their functions by paring the wood; sawing teeth act by first cutting a line on each side of the kerf and then removing the unsupported center by scraping, while the intermediates perform more or less of both these functions.

Cutting saws are applied to slitting or ripping purposes, and sawing ones to cutting across grain; and yet the action of the two is in one respect identical—that is to say, in both instances the teeth sever the fiber of the kerf from the main body of the wood before attempting to entirely dislodge it. The fiber of the wood lies lengthwise of the log, and the cutting edge of the ripping tooth lies at about a right angle to it, so that the edge severs the fiber, and the wedge of the throat face removes it. So likewise in a cross-cut saw, the cutting edge strikes the fiber at a right angle to its length and severs it, on each side of the kerf, from the main body of the log before attempting to dislodge it; hence the difference between the forms of the two is an adaptation to accomplish, in both cases, the same order of operations and results.

In order to clearly understand the principles governing the shapes of teeth, it is necessary to consider the directions in which the strains are placed upon the teeth, and to what manner those directions are influenced by alterations in the angles of the faces whose function forms the cutting edge. Here again we shall find that the shape of these cutting edges, in both the slitting and the cross-cut teeth, are, relative to the duty, as much alike in form as the thickness of the saw blade renders it possible to get them; that is to say in a slitting saw the rake is all in front of the tooth, because the cutting duty is in front; and in the cross-cut, the rake is on the side, because the cutting duty is there also; the advance and cutting edge operating at a right angle to the length of the fibre of the wood.

Suppose fig. 1 to represent the magnified teeth of a common hand saw, and that the front edges of the teeth are beveled as shown, which is called fleaming, then the strain placed by the duty on that face, being at a right angle to its plane; there will be induced a pressure in the direction shown by the arrows in the edge view, and operating to spring each tooth in the direction of its set; so that if one of the teeth possesses a greater degree of angle or fleam than the others, it will spring more in that direction and perform more duty than the others. As a natural consequence, it will become dull sooner and, when dulled, will spring away from its duty; that is to say—in a direction to reduce the amount of its set, and induce both friction and heating. Suppose, on the other hand, that in fig. 2 we have a saw with no side angle on the front face of the tooth, there will be in that case no strain tending to spring the tooth sideways, save that due to the set of the teeth, in which respect both forms of teeth are affected. It must be borne in mind, that this cross angle, or fleam, on the front face, increases with the thickness of the saw-blade; and, conversely, decreases with the thinness of the same; and this it is which, in conjunction with the comparative slowness of the duty, renders it admissible and desirable in most hand saws when it would not be in gangs or thick circular saws. Furthermore, the resistance being less, it is more appropriate for the softer woods and least applicable for hemlock and spruce, the knots of which would, from their hardness, break the teeth, if appreciably weakened by cross angle or rake.

Fig. 1.

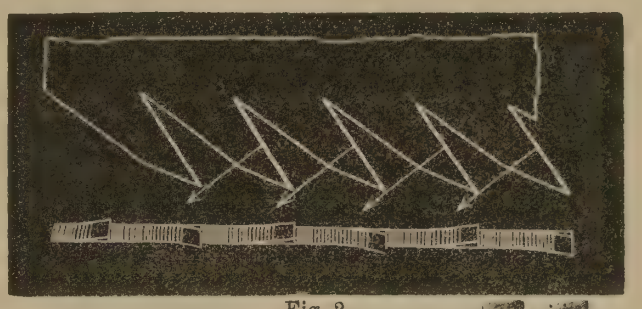


Fig. 2.

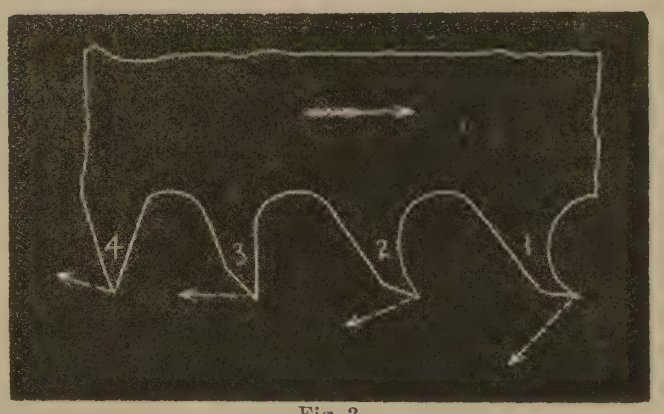


Fig. 3.

If the front or throat face were given an angle in the direction shown in fig. 2, it would present very keen edge, rendering the tooth especially liable to spring, and, as a consequence, to break—particularly if it were a long one and used upon hard wood. In a cross-cut saw, the angle of the faces running across the thickness of the teeth, induces a strain sideways; also tending to give the teeth more set, as shown in the edge view at fig. 1. The back face of the tooth must stand at an angle sufficient to give strength and keenness to the cutting edge. In fig. 3, tooth No. 1 has a maximum of front and a minimum of back rake; the latter having no duty to perform, save it be to support the cutting edge and give it sufficient clearance. No. 2, having less front rake, or hook, as it is commonly called, has more back rake, and, as a consequence, the latter enters somewhat more into the element of the keenness of its edge. In No. 3, the front edge having no hook, or rake, the back one has considerable; and in No. 4, the front edge being sloped backwards, the back edge determines to a very great extent the keenness.

It is very apparent to the most casual observer that the form shown at No. 1 is the keenest tooth, and that the cutting edge is well supported by the metal behind it; but its great defect is, that it receives the strain of the cut in the direction of the arrow, and as a result, when it strikes a knot, it springs deeper into its cut, and therefore breaks off—especially if the tooth is a long one. Tooth No. 2 is less keen, and the edge is not so well supported by the metal behind it; but its reduced liability to spring more than compensates for the difference. No. 3, having its front edge at a right angle to the depth of the cut, has a scraping rather than a cutting edge; and is furthermore considerably weakened by the sharpness of the angle of the back face.

We have now to consider the effect upon these teeth of the set which, in any case, tends to spring them, because the cutting edge is thrown in each case to one side of the blade. If the front edge is fleamed, as shown in fig. 1, the set aids the fleam to spring the teeth in the direction of the set; while if it is square across (as in fig. 2), the strain is less—although still in the same direction. Were any set given to No. 1, in fig. 3, its tendency to spring sideways, as well as into the cut, would cause it to buckle and bend in every direction; while No. 3 might be given ample set, even though the length of the tooth was excessive.

So long then as the teeth are sharp, the set springs the blade in a wave line or corrugation, the amount of which varies with the angle of the front face and the amount of the set. So Soon, however, as the outside corner of the tooth gets dull, (and it always dulls there first, because it is there that the cutting is done), the tooth springs in the opposite direction; reducing the set and thus causing friction, heating, and rough work; because when the dull tooth springs away from its duty, or when any successive number of teeth do so, the first sharp one performs, in addition to its

own proper duty, that which the dull teeth have skipped. This gives to the sharp tooth undue duty and excessive spring in the direction of its set.

It is of the utmost consequence, then, that the setting be performed uniformly. In this connection another and important point must be attended to; and that is, that as the natural tendency of the teeth is, being made straight, to remain so; then when a tooth *is* bent (the convex side of the tooth being stretched and the concave side compressed), the middle of the thickness of the metal resists both the stretching and compression, and retains a tension tending to force the tooth *back* from its set. As a result, a comparatively slight pressure in the proper direction will reduce the amount of the set. To obviate this defect, it is an excellent plan, first, to give to the whole of the teeth an excess of set, and then to reduce it so that the metal in the middle of the tooth shall be given a more permanent set by relieving it of the central tension referred to, or rather by reversing the direction of the resisting tension. The set should be not a straight angle, but a curve, which gives to the cutting corner an element of increased sharpness.

In many cases but little set is given, and the clearance is partly obtained by spreading the points of the teeth. But this is only permissible to a limited extent; because, in the spreading, the grain of the steel is upset, and its strength impaired, causing the points to break off. The degree of hardness of the blade is an element to be, in this connection, considered; for the harder the blade is, the more the strength is destroyed by upsetting, rendering its utility very doubtful for the harder kinds of wood. For the softer kinds, however, upsetting on soft blades is found to be of advantage. To accomplish this spreading a "set" is used; and unless this "set" is held, in each case, in the same relative position to the tooth, the angles and the keenness are varied, and irregular action, spring, and uneven dulling ensues.

We may next consider the length of the teeth, and this depends largely upon the nature of the duty. The longer the tooth, the weaker and more liable it is to spring from any of the causes already enumerated; but at the same time this is, in a great measure, compensated for in the extra freedom given to the dust. It is evident that there must be between the teeth of a saw sufficient space to afford ample room for the amount of dust a tooth will remove at its maximum cut; and if this room cannot be given in length of tooth, it must be allowed in the distance of the teeth one from the other. For use upon hard woods, a shorter tooth, with wider spaces between, is desirable; because, though the dust is finer (and less liable on that account to clog in the teeth), yet the duty is greater, and hence the spring more; and knots are, therefore, more liable to break the teeth. In any event, the teeth should be of an equal height, otherwise the protruding ones are subject to an excess of duty, inducing both spring and breakage; besides reducing the capacity of the saw by diminishing the number of cutting teeth, and rendering their dulling more rapid.

The shape of the throat of the teeth should be either rounding or at least of as obtuse an angle as possible, so as not to hold the dust; and the depth of the throats should be equal, because they regulate the length, and therefore, in a great measure, the strength of the teeth, which is not of so much consequence, so far as regards the resisting the direct strain of the cut, as it is in resisting the tendency to spring sideways, and therefore in altering the amount of the set.

The shape of the throat is of far more importance in short teeth, and in those comparatively close together, than in those long or wider apart. Close teeth are, it is true, better adapted for light duty; because in that case the amount of duty (and hence of dust removed at a cut) being comparatively small, not so much room between the teeth is requisite to accommodate it; and such room may be given in the length of the tooth, unless its front face is much "fleaming," as shown in Fig. 1—in which case, unless the feed is light (as in the case of a hard saw) the spring would be excessive.

From these considerations we should arrive at a form of tooth approaching that shown in Fig. 4, as applicable to gang saws for general purposes. The principles upon

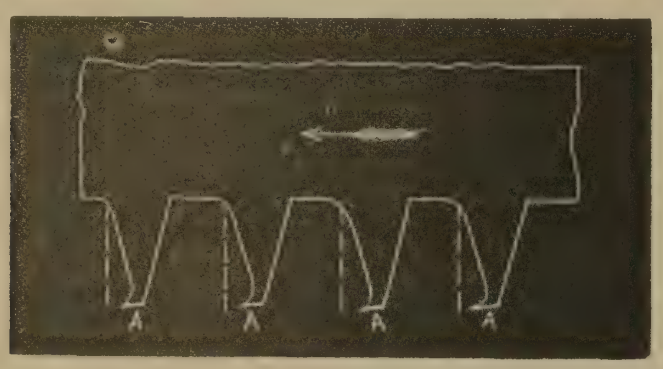


Fig. 4.

which this form of tooth is constructed are as follows: The front face of the tooth is given a slight rake or hook, which may be given by swaging; and the tendency (given by the rake) to spring into the cut is compensated for by the point of the tooth standing back from the front base, as shown by the dotted lines. By reason of the front rake, the edge can be made keen enough without too much angle on the back face at A, A, A, A, in Fig. 4; hence the cutting edge is well supported by the metal behind it. It is in fact well sustained; the teeth are sufficiently wide apart and deep to afford ample room for the dust, and the corners near the point of the tooth and at the base (in front) are rounded, so that the dust shall not lodge there. Furthermore, the liability to spring, from the set is, in a great measure, contracted by the cutting edge being pulled instead of being pushed to its cut; and in all cases where spring is a serious defect, pulling is resorted to. Thus in an iron planing machine, the tools are often bent back; while in rifle-barrel boring and rifling, pushing is found to be altogether inadmissible. The spring of the body of the blade is, in frame saws, resisted by the tension of the saw in the frame; but this does not prevent the individual teeth from springing from their bases.

In solid circular saws, the principles we have considered have especial importance, because of the liability of the saw to spring sideways. In those having inserted teeth we have another consideration. In a solid saw, the destruction of one or two teeth necessitates the filing down of all the others to the size and radius of the broken ones; and the teeth require to have "set," and if this set is partly obtained by swaging, we have the liability to break and to spring before referred to. By inserting the teeth we may replace the broken by new ones, and may reduce the latter to the size of those uninjured, and thus maintain both the size and velocity of the saw. A greater advantage, however, is that clearance may be given to the teeth, by giving them a spread at and towards the cutting edge; and since this spread is made to extend equally on each side of the thickness of the saw blade, the tendency to spring induced by having the set all on one side (as shown in the edge view at Fig. 2), is avoided—providing we file the front face of the teeth square across (as shown in Fig. 2) and not fleaming (as shown at Fig. 1). To off-set this, we have two considerations: first, that such set can be maintained only by swaging the teeth; which, as already explained, weakens them; and secondly, such teeth are apt in time to become loosened in their sockets. The first objection can be removed only by a resort already being put into practice, and that is by separating the cutting part of the teeth from the shank, and thus composing the inserted teeth of a shank and a bit, so that the bit may be taken out and ground up, say three, times giving it four runs; by which time its clearance will, it is true, be worn away, but the inexpensiveness of providing the bits, compared to having to replace the whole tooth and shank, will make the operation desirable. Furthermore, the second set of bits may be made a trifle larger than the first, to take up any wear that may have taken place in the sockets.

To still further remedy the second objection, the teeth should be made as narrow as is consistent with clearance; which will not only reduce the width of the kerf, and thus save timber but by reducing the amount of the duty, will correspondingly diminish the strain on the socket. Another advantage possessed by this plan, is that the teeth may be tempered to a harder degree; for good steel tempered to a blue, will not stand swaging without having the strength almost destroyed; and hence teeth depending upon swaging for their clearance, are left too soft. Another inducement to have the blade soft is to facilitate the filing; but this is obviated when (the teeth, being inserted bits only, and intended to be sharpened but three times) the amount of filing is reduced to a minimum, and may, from the shape of the bits, be dispensed with altogether by the substitution of an emery wheel. An objection to any form of inserted teeth is that the shank depends upon the spring of the socket to hold it in place; but this defect is more than compensated for in the gain due to having the tooth spread on both sides of the thickness of the blade, instead of having set on one side only. Furthermore, the blade may be finished with false shanks and teeth placed in the sockets, thus allowing for the spring.

The main advantage of the circular saw is in the ease with which it may be operated, and the high rate of speed at which it may be run. But to off-set this, it requires continuous attendance; since the work is performed so rapidly as to be in the operator's hands nearly all the time, chisel teeth require a large amount of clearance in the throat to give room for the dust; because, from their shapes, the teeth possess all the obtainable advantages, inasmuch as the hook (and hence the keenness) may be greater than is possible in frame saws; and furthermore, the angle of the back face may be less, and the cutting edge is, as a result, better supported by the metal behind it. Hence they take a coarser feed, and have more dust to dispose of. Taking all these things into consideration, and not omitting the fact that circular saws, save for edges, cannot be used in gangs, there appears no reason why the future is not full of promise for inserted teeth circular saws.

We may now turn our attention to band sawing; and here again the principles governing the shapes of the teeth are the same; but we have other considerations claiming attention. For fine small work, the band saw already stands unrivalled. The obstacles which have so far prevented its general application to large work are: first, it requires much skill to operate; secondly, it is difficult, where the depth of the cut is great, to give the teeth sufficient throat to provide dust room; and as a result, it packs between the teeth, which in turn packs the dust firmly to the sides of the kerf. A third disadvantage lies in that the tension of the blades must be kept even; and is liable to vary even from alterations in the temperature. On the other hand, the speed of a band saw may be as great as or greater than that of circular saws; and the thickness of the blade may be reduced to nearly one half that of the circular, which involves a considerable saving in power, as well as in material. The clearance may be assisted by placing the teeth wider apart; the rate of duty being maintained by a commensurate increase of speed. In short, there appears no reason why the band saw should not be more generally adopted, providing it is made and used with sufficient care. This remark applies equally to circular saws; the difference being in favor of the latter, only in that it may be made and used with less skill. Indeed our remarks will disclose, all through, that a great deal more depends in all cases upon exactitude, both in the form and in the dressing of the teeth, than in the particular method of sawing; and it would therefore appear that, as our experience with both circular and band saws increases, they must continue to make inroads upon the present position held by frame saws, because of the relative greater capacity of the two former, notwithstanding the increase of cost due to their requiring continuous attendance by the operatives. For the increase of duty is greater in proportion to the total expenses, than is the increase of wages in proportion to the duty performed.

OUR ILLUSTRATIONS, usually abundant, are this week crowded out by articles which, from their nature, do not admit of or require engravings. We would state to those who see our journal for the first time—and in this we refer more especially to our Northwestern friends, whom we hope to meet again regularly—that our average number of illustrations is over twenty in each weekly issue; this average we shall increase by the addition of "insets" especially devoted to engravings. We hope to present the first of these insets next week.

"Open books and signed articles" are our guarantee as to reliability.

EXAMINATION OF BISMUTH ORE FROM THE NEIGHBORHOOD OF BEAVER, UTAH.

By Henry Pemberton, Jr.

Several descriptions of the deposits of bismuth, known as the "Starr King" and "San Francisco" lodes, near Beaver City, Utah, as well as an account of the properties and uses of the metal, have appeared in the Polytechnic Review of April 10, July 29, and August 19 of this year.

During the past summer months I have had occasion to analyze samples of this ore received from gentlemen interested in the mines, and as no other deposits of any size have been discovered in the United States, it is particularly interesting—now that these mines, on account of their large extent, promise to play an important part in the bismuth industry—and is especially desirable to examine the ore as regards its purity and chemical composition.

The bismuth exists partly as sulphide, and partly as carbonate, disseminated through a hornblendic rock containing garnets, quartz, calcite and pyrite; the specific gravity of the gangue being about 3, and that of the bismuth minerals varying from 6·4 to 6·9. From the difference in the specific gravity the bismuth can easily be concentrated, and samples have been received that have been concentrated by "Krom's Dry Concentrator" up to a specfiic gravity of 4·95 and 5·12.

In all, I have examined four different samples—two of the ore as it is found naturally, and two of the ore that had been concentrated.

No. 1 is a sample sent me by Dr. Graff marked: "This parcel is an average fairly taken by Frank Foote, Esq., assayer (for assay), of all the samples taken from all the openings in the "San Francisco" and "Starr King" bismuth lodes, from the surface to sixty feet down the main shaft."

No. 2 is an average of all the ore as it naturally runs, taken and given me by Dr. C. F. Winslow (the owner of the properties).

No. 3 is an average of the ore concentrated by Krom's Dry Concentrator from a general run of the ore, also received from Dr. Winslow.

A complete analysis was not undertaken in any case, since no rational formula could be derived, on account of the number and mixture of foreign minerals present. But the following is the result of the determinations that were made.

	1. Average run of lode from Frank Foote, Esq.	2. Average of ore from Dr. Winslow.	3. Concentrated ore from Dr. Winslow.
Bismuth,	6·40 per cent.	3·66 per cent.	39·00 per cent.
Sulphur,	0·92 "	0·26 "	3·18 "
Copper,	0·28 "	0·14 "	0·64 "
Cobalt (some nickel),	0·10 "	0·58 "	Undetermined.
Tellurium,			0·42 per cent.
Specific gravity,	3·37 "	3·22 "	4·95 "

The ore contains neither arsenic, antimony, nor lead.

A few days before this article was written, a fourth sample was received from Dr. Winslow, being another average of the ore concentrated as above. I did not have time to make any quantitative determinations, excepting that of specific gravity, which was found to be 5·12. This, calculating from the specific gravity and composition of No. 3, is equal to 42·8 per cent. bismuth.

A short description of this lode was published in the *Utah Weekly Miner*, i, 32, and is now going the rounds of the scientific press—as I have seen it in two of them. Among other things, or errors, is the following remark. "The ore is extremely hard, being filled garnets, and impregnated with arsenic."

Concerning the arsenic, this is a mistake, as neither arsenic nor antimony is present. On reading the article I made another careful examination for these two metals, but as before, with entirely negative results. This examination was made on the above concentrated ore, No. 4. It may be interesting, perhaps, to observe that molybdenum was detected in this sample, the amount of which, however, I did not determine—perhaps a quarter of one per cent. (on the concentrated ore). As there is quite a demand for this metal in all laboratories—it is used in the determination of phosphoric acid—it might possibly be worth while to separate it.

The entire absence of arsenic and antimony—particularly when the bismuth is used medicinally—is a most excellent feature of these deposits. The United States Dispensatory, speaking of the preparation of the sub-carbonate of bismuth, says: "Metallic bismuth generally contains arsenic . . . it is on this account that the present formula is so elaborate." Again, speaking of the properties of the subnitrate: "The contradictory statements, as to the safety of this preparation, can be explained only on the supposition that it is sometimes poisonous by the presence of *arsenic*." . .

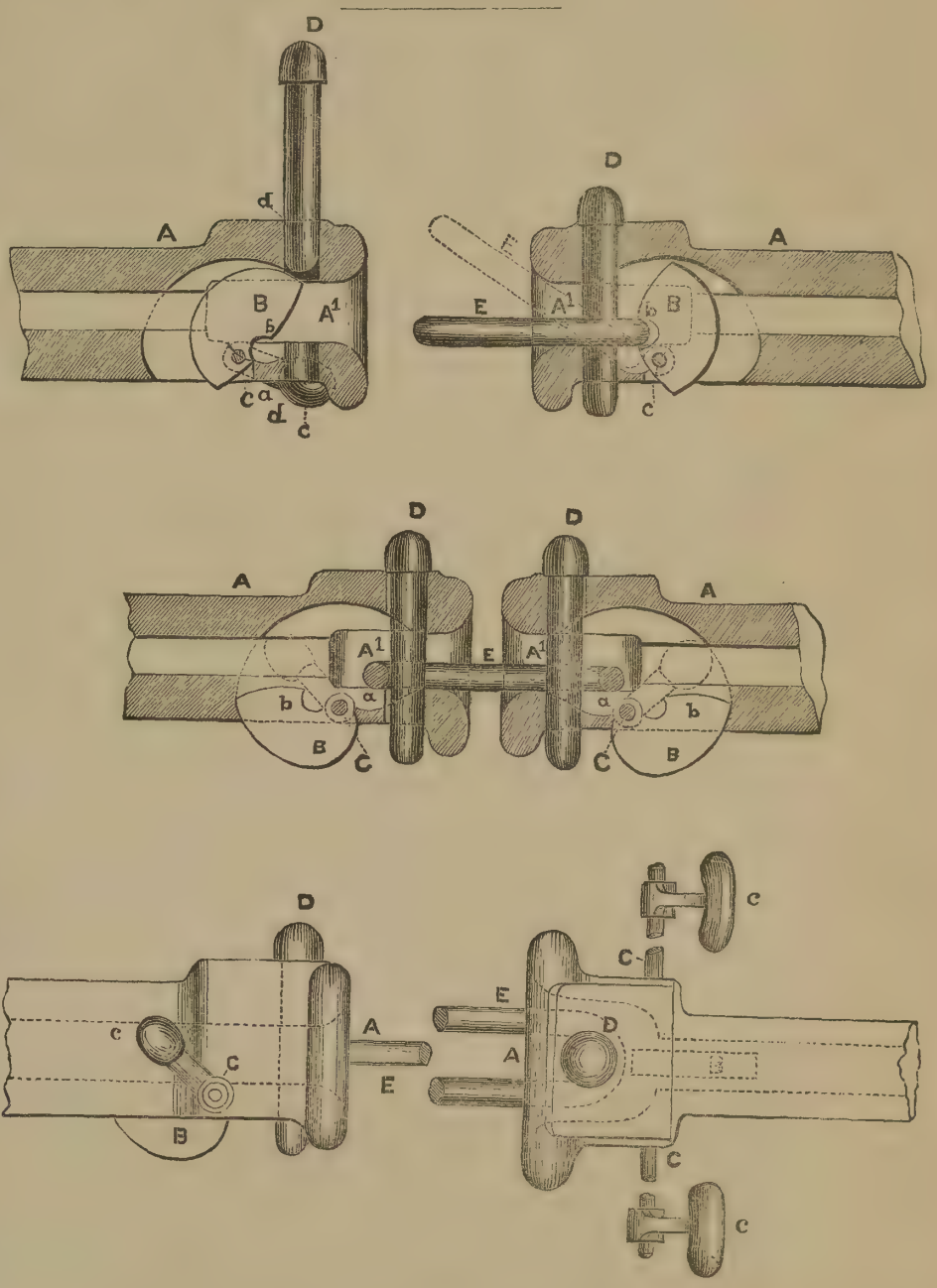
Also in Wagner's *Jahresbericht*, for 1875, article "Bismuth," p. 275, is the following, apropos to the above,—I translate literally. "In the year 1869, the Bolivian and Peruvian bismuth entered into the London market, creating quite an excitement, and drove out, for a time, the old established Saxon metal. But it very shortly appeared that bismuth, smelted from the South American ores, was very strongly contaminated with tin, antimony, and copper; and in consequence of this the demand sank. It was also exactly on this account that, in 1870, the importation of the ore from Peru entirely ceased."

When, therefore, we take into consideration the purity, and freedom from hurtful substances characteristic of this ore, together with the almost inexhaustible extent of the deposits, it is safe to predict that, just as Nevada has taken the lead in supplying commerce with her silver, so will her sister Utah and next door neighbor rival all other sources in the quality and quantity of her bismuth.

Laboratory of the Franklin Institute,
Philadelphia, Oct. 14, 1876.

The rapid increase in the number of foreign subscribers is peculiarly gratifying.

Further "Saw Mill Numbers."—We would say to those who receive this number, containing Mr. Rose's practical article on "Saws and Sawing," that there will be further illustrated papers on kindred topics, by the same writer, and by our Mr. Grimshaw, embracing the whole field of saws, sawing, and saw mill appliances. These papers cannot fail to prove of great interest and value to sawyers and wood-workers; and as they will be not only impartial, but over reputable and well-known names as a guarante, they may be relied upon in every way. The Review is also constantly illustrating and describing new and improved wood-working machinery of every kind; treating of modes of fire-proofing and preserving shingles and lumber bending of timber, etc. It would then be a valuable medium of information for those interested in wood-working of any kind; and we would be glad to receive from them whom we now have the pleasure of meeting for the first time, subscription and by the year ($3, including postage), or for one month on trial, twenty-five cents. Prof. R. H. Thurston's article on Lubricants, to appear in our issue of 23d inst,, will be of special value to all using fast-running machinery. We shall keep our readers fully posted concerning economy in fuel; selection, care and use of boilers, engines, shafting, pulleys, belting, etc.



TAIT'S IMPROVED CAR COUPLER.

[Canadian Section, Machinery Hall.]

The annexed cuts show so very clearly the construction and operation of this car-coupler, that no detailed explanation is necessary. The claims of the inventor are as follows:

1st. It is really an automatic coupler, as it holds the pin and guides it in its descent, and holds the link in any position, either elevated or depressed, and so will couple cars of greatly varying heights. 2d. It will work with any other coupler using link and pin. 3d. It removes all danger to life and limb, as the operator need not be near the car when in the act of coupling. 4th. A whole train can be coupled by one operator. 5th. It never fails to couple securely. 6th. It is stronger than the ordinary coupler by at least one-fourth, and fashioned for wear and tear. 7th. It is neat in appearance, simple in construction, durable in use, and costs but little more than the common cast-iron coupler.

Any further information required will be given on application to R. K. Chisholm, Oakville, Canada.

We have received a number of offers of advertisements, payable in case the dealer received custom therefrom. We can and do guarantee the extent, quality, and direction of our circulation; but we cannot, and do not guarantee the cheapness and goodness of any wares, nor the condition of the market.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The Channel Tunnel.—From an elaborate review of the present aspect of this project, which has lately appeared in the London *Standard*, we glean the following facts concerning the progress that has been made.

The scheme in question, under Sir John Hawkshaw on the English side, and M. La Vallée on the French side, appeared more than a year ago to be making substantial progress. Three railway companies had announced their readiness to contribute their contingents of £20,000 each; and an English company had expressed its willingness to contribute the balance of the £80,000, which, according to Sir John Hawkshaw's estimates, were necessary for the trial works then in contemplation, and which were to have been at once proceeded with at Saint Margaret's Bay, three or four miles to the east of Dover. The *Standard*, replying to the query, as to the progress made by the English, affirms that it has amounted to less than nothing—retrogression. One of the parties interested has clung to the £80,000 trial works at Dover, involving a shaft nineteen feet in diameter, colossal pumping engines, and a submarine driftway 7 feet square. Another party, in the railway interest, advocated the expenditure of a few thousands at a time for smaller trial works to make a shaft 7 or 8 feet in diameter, less pumping power, and as moderate a driftway under the channel as could practically be driven. By this means, it was claimed, the requisite practical knowledge of the difficulties of the work in contemplation could be gained with the minimum of expenditure; £20,000 being named as the sum for which such a shaft could be driven and a suitable driftway carried under the sea for the distance of a third of a mile, and pumping machinery erected capable of pumping 500,000 gallons per day. The result of this conflict of opinion appears to have been that those who were depended upon to supply the funds needed in the preliminary works, have either withdrawn their influence or have held aloof, and so the matter on the English side remains at a dead lock.

On the French side, we are informed, on the same authority, there has been quiet and steady onward movement on a small but useful scale. The dredgings of Sir John Hawkshaw, on that side of the channel, were confirmed and enlarged by M. La Vallée and his staff some time ago. Since September 9th, year 1875, the English sea-bottom of the channel has been sounded and additional confirmations and more precise knowledge obtained; and a boring was commenced, and is just finished at Sangatte, about six or seven miles west of Calais. The official report of the French engineers upon the results they have obtained have not yet been made public, but the following statements afford as complete a *resumé* thereof as can be made from extra-official sources. The boring was commenced at Sangatte on the upper white chalk at somewhat less than half its thickness, it has penetrated the lower white chalk, and has gone through about 66 metres of gray chalk, identical in its beds and fossils and characters with the gray chalk on the English coast between Abbot's Cliffe and Folkstone. It has further penetrated into the Gault clay after passing a thin band of dark green upper Green-sand; the total depth of the boring being 133 metres, and the diameter 24 centimetres. As one of the objects of these borings was to ascertain the amount of water that is likely to be met with in the final operations, the shaft has been lined to a considerable depth with iron tubing of different diameters, let in telescope-wise, the annular space between the tubes being filled with cement to render the same water-tight and to consolidate the whole. On this score, the results attained appear to have been quite favorable, the amount of infiltrations being quite small, and of spring water only, notwithstanding the proximity of the sea. The borings have therefore demonstrated, quite independently of the shore sections, the character and thickness of the stratum through which the tunnel is to be driven; and that, although the thickness of the several strata all diminish towards the French coast, they are yet of sufficient magnitude for all the engineering requirements of the contemplated work. All the knowledge gained by this means, however favorable it may appear, neither proves nor disproves the hostile theories which have long existed and still exist as to the occurrence of a vertical fissure along the whole medium line of the English Channel, and which discussion will only be settled when the driftways of the tunnel itself are actually driven from the shores of both countries, and are about to meet midway under the bottom of the sea.*

The future disposition of this magnificent enterprise, to quote the opinion of a cautious contributor to our leading year-book, † will probably be that the preliminary work, involving the cutting of galleries from both sides for some distance under the sea, will be carried forward by private enterprise, until the feasibility of the undertaking is either disproved or established beyond cavil. Should this last prove to be the case, as seems at least probable, the two governments interested will doubtless be asked to come to the aid of the enterprise by the grant of a liberal subsidy.

* For a r view of the several plans prop sed for this enterprise, consult this journal, i, 60

† Harper's Annual Record of Science and Industry, 1875, p. cclvi.

The Mississippi Jetties.—The *Railway World*, after careful consideration of all that has been been recently published by the New Orleans journals, says that there can be no reasonable doubt of the Eads jetty experiments. It is said that the channel between the jetties is everywhere more than 200 feet in width for a depth of 20 feet at average flood tide; and in the center of this channel there is a minimum depth of 22½ to 23 feet, and a maximum depth of 30 feet. Thus vessels are now sure of having a much wider channel across the bar than has ever been offered at Southwest pass, where dredging boats have been maintained by the government for years past at an annual expense of several hundred thousand dollars. One of the results claimed is that hereafter increased facilities for cheap ocean transportation will always be insured at comparatively little cost for the dwellers in the Mississippi Valley and its tributaries. But one of the impending difficulties is apprehended opposition to additional appropriations by the national government. The theory has been promulgated that the jetties damage the channel over the bar at Southwest Pass, and that various old interests of pilots and towing associations have been injuriously affected; and it remains to be seen whether Captain Eads will be fully sustained, and whether all the anticipated benefits of his project will be realized. [*Iron Age*, Nov. 23, 1876.]

MINING, METALLURGY AND MINERALOGY.

Albertite.—A very curious mineral known as albertite, is found in New Brunswick. It occurs in connection with calcareo-bituminous shales, and has been by some regarded as true coal, by others as a variety of jet, and by others again as more nearly related to asphaltum. The true nature of the mineral was made the basis of a law suit in Scotland a few years ago, in which the amount involved was something more than a million of pounds sterling; as the decision settled the question of the liability to pay a royalty. It resembles asphaltum very closely, being very black, brittle and lustrous, and like asphaltum, is destitute of structure, but differs from it in fusibility and in its relation to various solvents. It differs from true coal in being of one quality throughout, in containing no traces of vegetable tissues, and in its mode of occurrence as a vein and not as a bed. The vein occupies an irregular and nearly vertical fissure, and varies from one inch to seventeen feet in thickness. It has been mined to the depth of 1,162 feet. The accompanying shales are abundantly filled with the remains of fossil fishes, and it is not improbable that from these, in part at least, the mineral was derived, existing at first in a fluid or semi-fluid state. Vegetable remains are almost entirely wanting in the shales. During twelve years since the discovery, there have been shipped 154,800 tons of albertite, chiefly to the United States, where it has been used for the manufacture of oil, and for the admixture with bituminous coal in the manufacture of illuminating gas. It is admirably adapted for either of these purposes, yielding one hundred gallons of crude oil, or 14,500 cubic feet of gas of superior illuminating power per ton. The price varies from $15 to $30, gold, per ton. [*Iron Age*, Nov. 23, 1876.]

The Seagersville Slate Company, of Lehigh county, Pa., lately shipped 10,000 squares of slate to a firm in London. They also have several unfilled orders on hand from slate dealers in the Old World.

State Mine Inspector Roy estimates that the coal production of Ohio for 1876 will hardly reach 3,000,000 tons. The production in 1875 was 4,800,000 tons. None but the very best of mines in the State are running on full time; others are running on half time, and another class from four to five days per month. [*Am. Manuf.* Nov. 24th, 1876.]

A New Mineral.—Professor Von Lasaulx, of Breslau, exhibited specimens of a new mineral which he described, from its behavior before the blow-pipe, under the name of Melanophlogite. It crystallized in small cubes, which were seated on crystals of sulphur and cœlestine from Girgenti in Sicily. The mineral contained 86 per cent. of silica, 3 per cent. of water, small quantities of iron and strontium, with 7 per cent. of sulphuric acid or some acid of the thionic series not yet determined. [*Proceed. British Assoc., through Sci. Am. Supp.* ii, 764.]

CHEMISTRY, PHYSICS AND TECHNOLOGY.

The Properties of Gallium.—The recently discovered metal, gallium, melts at 81.1° Fahr., so that it liquefies when held in the hand. When solid, the metal is hard and resistant, even to a few degrees below the melting point. It can be cut, and possesses a slight malleability. When fused, it adheres easily to glass, on which it forms a beautiful mirror, whiter than that produced by mercury. It oxidizes but very superficially when heated to redness in the air, and does not become volatile. The density at 59° Fahr. is 4.7. Excepting mercury, which only becomes solid at —40° Fahr., there is no other element which liquefies at so low a temperature as gallium. [*New Remedies*, v, 333.]

Antidote to Strychnia.—The East Indian physicians recommend nicotia as the surest antidote, which is given in exceedingly small quantities in sherry several times a day. In default of nicotia, decoction of tobacco leaves (half an ounce to a pint) is given. [*Am. Jour. of Pharm.*]

Ink Stains may be removed from colored fabrics which would not bear the application of acids, chloride of lime or other strong agents, by a concentrated solution of sodium pyrophosphate (*R. Bœttger*); old stains do not yield at once, but required a prolonged application. [*New Remedies*, v. 352.]

A Steam Lamp.—Mr. B. Lavendar, Kirkcaldy, read a paper descriptive of a lamp specially adapted for collieries, the merit of which was that it gave a great light at a small cost. The lamp, as shown at Kelvin Grove Museum, consists of a glass lantern 18 inches square, with a funnel 24 inches high. Into this is introduced a jet of steam, about one sixteenth inch in diameter, the object of which is to create a partial vacuum in the lantern. The consequence is, that the surrounding air is forced through the burner of the lamp, causing almost complete combustion of the oil. A very brilliant light is thus produced, which is increased, partly owing to the products of combustion being continously removed and a volume of fresh air being introduced. The results obtained from a 4-inch wick had been equal to a light of upward of 600 sperm candles. [*Proceed. British Assoc, through Sci. Am. Supp.* ii, 764.]

Mucilage for Labels.—Those who are engaged in gumming labels are often annoyed by the curling up of the edges or corners. A remedy for this is to add to the mucilage a little salt, sugar, and glycerin, and the paper, if not exposed to too strong a warmth, will not curl. A very small quantity of glycerin must be used, as a large proportion will prolong the process of drying. [*New Remedies*, v. 352.]

Contribution to the Theory of Luminous Flames.—Dr. Karl Heumann.—In this part of his treatise the author arrives at important results, both theoretical and practical. He shows that the carbon in the flame exists as a solid body and not, as Frankland assumes, in the state of vapor. He finds that gas-jets of steatite are decidedly preferable to those of iron, since they comsume less gas for an equal strength of light. Metallic jets, in general, notably enfeeble the light. He refers to the results obtained by the Commission of the English Board of Trade, who reported, in opposition to the view of Vogel, that a refrigeration of the gas does not decrease the amount of light, and considers that they must have experimented with a kind of gas poor in hydrocarbons capable of condensation. On the contrary, he finds that if the jet and the outflowing current of gas are both strongly heated, the luminous effect is increased to an extraordinary degree. [*Chem. News*, xxxiv, 206.]

The Lowest Temperature in the Arctic Seas recorded by Captain Ross, in 1820, was 50° below zero; by Dr. Kane, in 1853, 70°; by Dr. Hayes, in 1861, 68½°; by Captain Nares, in 1876, 72°. A Russian traveller named Niveroff, once registered 72° at Yakoutsk, Siberia. [*Iron Age*, Nov, 23, 1876.]

The Fac-Simile Telegraph.—There was in operation between the Signal Service section of the Centennial Exhibition and the Chief Signal Office at Washington, on a circuit about 150 miles long, an instrument which transmits by telegraph the weather maps of the Signal Service, heretofore produced only in Washington. These maps contain what are called the isobaric lines, or lines running through the points of equal barometric pressure; and they show as well the different areas of the country. It has hitherto been impossible to present these maps to the public, owing to the inability of the ordinary telegraph to transmit anything but words and figures. This invention reproduces the map entire, with its lines and figures. It is then lithographed and printed for distribution on the presses with which the Signal Office is supplied.

The method may be briefly described as follows: The

map, or message, to be sent, is first written upon ordinary paper with ink in which a little glycerin has been mixed; then before the ink is dry it is sprinkled with some powdered shellac, which adheres to the ink. The manuscript is then passed between rollers with the face against a piece of hot zinc. The latter takes up the shellac, and a negative is produced in shellac, the best non-conductor of electricity, upon zinc, a good conductor. This plate is then bent around a cylinder which is rapidly revolved, while a metalic point connected with the conducting wire is held to its surface by a spring and makes a spiral line over the face of the cylinder. At the receiving instrument a similar point traverses the face of a similar cylinder upon which is placed a piece of chemically prepared paper.

As the transmitting point comes to the line of writing the receiving point makes a dot on the paper by decomposing the chemically prepared paper, and as every portion of the writing is touched by the transmitting point, the result will be a *fac simile* of the original writing or device. To produce this result it is necessary, of course, that the two cylinders should revolve exactly together, as if one should go faster than the other the discolored paper would be a confused mass of dots. In this consists the great novelty of the invention. Isochronous motion of the cylinders is secured by a magnet at the receiving station, which at each revolution of the transmitting cylinder accelerates it, if too slow, or retards it if too fast. It is believed that this invention will prove a valuable adjunct to the present systems of telegraphy, or may, with further improvement, supersede them. The inventors are William Edward Sawyer, of New York City, and James G. Smith, of Hackensack, New Jersey. [*Am. Manuf.* Nov. 24th, 1876.]

MISCELLANEOUS.

Fires and Fire Crackers.—The following suggestive facts are from a report made by H. H. Hall before the National Board of Underwriters:

It is the universal testimony of fire underwriters and chief engineers of fire departments that the losses by fire on the 3d and 4th of July, 1876, were less in number than any previous year in their remembrance. The widespread feeling of alarm and apprehension of serrious conflagration on the "Centennial" Fourth of July, influenced the public to take such precautions for the safety of property as the underwriters (incited by this Board) had recommended. Mayors of cities and chiefs of fire departments acted promptly and effectively upon the suggestions of this board and other associations of fire underwriters. It is strikingly suggestive of the dangers to which property is annually exposed that it is a source of general congratulation that the total losses of fire on the Fourth of July in consequence of the discharge of fireworks and fire-crackers, was less than half a million of dollars.

Because of the undisputed fact that the losses by fire on Independence Day of the present year were less than on any previous year, your committee considered the present a favorable time to collate figures showing the losses by fire and the extent of other casualities occasioned by the principal agents of American celebrations—fire-works and fire-crackers. That the returns might be complete, we forwarded a blank asking the desired information to all insurance companies doing business in this country; to chief engineers of fire departments, and chiefs of police in all cities and towns having a population of over 1,000 persons; and we have received and present to you the information received from 347 stock companies, 149 mutual companies, 849 chief engineers, 767 chiefs of police.

The invoice value of all fire-crackers imported since January 1, 1865, is less than $1,500,000, and the loss by two conflagrations in that period, traceable directly to them, amounts to upward of $15,000,000, and we find that on one day only of the present year the loss occasioned by these incendiaries amounted to 25 per cent. of the total invoice value of all imported in 1875. It is not an extravagant statement that every dollar's worth of fire-crackers imported into this country has occasioned a direct loss by fire of more than $100.

It appears from the tabulations furnished by Mr. Hall that fire-crackers caused damages on July 4th to 119 insured premises, resulting in losses to companies of $8,127·85, and fire-works other than crackers did damage to 132 premises, entailing insurance losses of $72,892.28, while gun-wads set five fires, for which the underwriters had to pay $33,242·22, making a total of insurance losses of $154,262·25 for 256 fires—all on account of the absurd practice of burning gunpowder to illustrate our patriotism!

From the returns secured from chief engineers and heads of police it further appears that there were on July 4th, 367 alarms, 365 fires, $240,979.46 damages, 34 fatal casualties, 17 serious casualties and 407 casualties of a slight character. Already 491 cities and towns have been heard from which have ordinances against fire works and fire-crackers; and it is devoutly to be hoped that the good work will not stop until every town and city in the land joins in this good work of reform.

Australian Telegraphy.—The Victorian cabinet has had under consideration, a written statement submitted by Captain Audley Coote to the Victorian Postmaster General, respecting the duplication of cable communication between Australia and Europe. Captain Coote, who represents the Indo-Australian Telegraph Company, and Messrs. Siemens Brothers, submits six distinct proposals, three of which are from Queensland, and three from Western Australia. The Queensland proposals respecting a second cable are: 1. From Normantown, *via* Batavia, Singapore, Tenasserim to Kurrachee, requiring a subsidy of 40,000*l.* per annum. 2. From Normantown, *via* Timour and Sourabaya to Singapore, Tenasserim, and Kurrachee, subsidy, 55,000*l* per annum. 3. From Normantown, *via* Timor and Sourabaya to Singapore, Penang, Tenasserim, and Kurrachee, subsidy 55,000*l.* per annum. By the line from Singapore to Tenasserim direct communication with India, China, England, and America would be obtained by an entirely distinct route. The Western Australian proposals are: 1. By cable from Exmouth Gulf, North-west Cape (W. A.) to Benjoewangie, thence *via* Batavia, Singapore, Tennasserim, and Kurrachee, subsidy 30,000*l.* per annum. 2. From Exmouth Gulf to Anjer or Batavia, thence to Singapore, Tennasserim, and Kurrachee, subsidy 35,000*l.* per annum. 3. By cable from Perth to Ceylon, thence to Kurrachee, terminal station of the Indo-European lines in India, subsidy, 55,000*l.* per annum. [*Hyd. Eng.*, i, 183,]

The Internal Navigation of Germany.—France is not the only country where they give serious attention to internal navigation by canals and rivers.

In Germany they are equally interested in this subject, and the Central Association for development of internal navigation has just asked the government to permit some new communications, among which we note the following: One line of communication between the Danube, Vistula, and the Oder; a canal of communication between Breslau and Glogan, Bromberg and Dantzig; a canal to facilitate communication between Berlin, Stettin, Rostock, Hamberg and Lubeck; another between Leipzig, Hanover, Meissen, Osnabruck and the Elbe.

The Association further demand the improvement of the canal Rhine-Main-Danube, and a union canal commencing at Ulm, between Lake Constance and and the Danube.

The object of the Association is to unite all the navigable waters of the German Empire, including the Danube, and thus to permit all the large towns of Germany and Austria to take part in general navigation.

This plan comprises a net-work of canals extending over 446 German miles, and will necessitate an outlay of 937,000,000 francs. [Translated from the *Revue Industrielle* by Dell S.—*Hyd. Eng.*, i, 185.]

Concerning Disinfectants.—A committee appointed by the Russian Government at the St. Petersburg Medical Academy, to investigate various purposed antiseptics and disinfectants, have arrived at the following conclusions:—1. Carbolic acid is the most efficient means against the development of ammoniacal gas, putrescense, and development of lower organisms in organic matter under decomposition, and is therefore the best antiseptic. 2. Vitriol, salts of zinc, and charcoal, are the best means for deodorizing matter under putrefaction. 3. The powders of Prof. Kittary, besides the properties they share in common with other carbolic disinfectants, deserve attention because of the isolated state of phenol in them and their contents of quick-lime, which absorbs moisture—the principal condition of each kind of putrefaction—as also some part of the gases. 6. Chloride of lime and permanganate of potash quickly destroys the lower organisms in putrid liquids. 7. The disinfectants certainly retard the putrid processes in orgonic bodies, but their influence is only temporary; as a means of purifying air in dwellings their influence is very small if not totally *nil*, because of the very small degree of concentration of their ingredients that can be used without injuring the health of inhabitants. 9. For uninhabited buildings the best disinfectants are nitrous acid and chlorine. [*Nature*, xv, 16.]

A New Manufacturing Industry.—We do not know of a manufacturing industry that holds out so fair a promise of profit and permanency to the careful and cautious investor at the present time as the linen manufacture. It is an industry that is almost new to this country, and the skill and machinery that might be turned into this channel could easily be made remunerative. Nearly every other branch of manufacture in the textile as well as the iron industries, if not overdone, is already worked fully up to the point of safe investment, and competition with the foreign manufacturer has long ceased to be a factor in the problem of profits. A far closer and fiercer competition is now waged between domestic manufacturers themselves. In the linen industry there would be little or no competition, except with the imported article. Last year we imported about fourteen and a half million dollars' worth of linen goods, which was two millions less than that of the year preceding. The falling off, of course, was not on account of any home supply, but simply that the hard times compelled people to economize and retrench.

Some enterprising parties have recently commenced the manufacture of linen on a small scale in Manchester, N. H., which promises to be a permanent success and to grow into a large establishment. The company sowed the flax, gathered the crop and prepared it for spinning. The outlay was small, and if the enterprise had not proved successful there would have been but a trifling loss. The field is open to the enterprise and skill of any man or company of men who may wish to invest capital in the most promising industry of the day. The flax is already cultivated to a considerable extent in many places mainly for the seed, while the straw is left to waste, or is used in in its most crude and least valuable form. Let linen manufactories be established in different localities in the West, and the raw material would be furnished in abundance at a merely nominal cost. We cannot too strongly urge practical men looking for investment in some industrial enterprise to look into the merits of this new industry, and not only save to the country a portion of this fifteen millions of dollars now annually sent abroad for the product of linen workers, but turn the profit of its manufacture into their own pockets. [*Western Manufac.*, iii, 272.]

Works of Sewerage.—In carrying into effect the work necessary for the sewerage of a town, three distinct operations have to be performed:—

1st. The drainage of the surface.
2d. The drainage of the subsoil.
3d. The removal of fæcal and other liquid refuse.

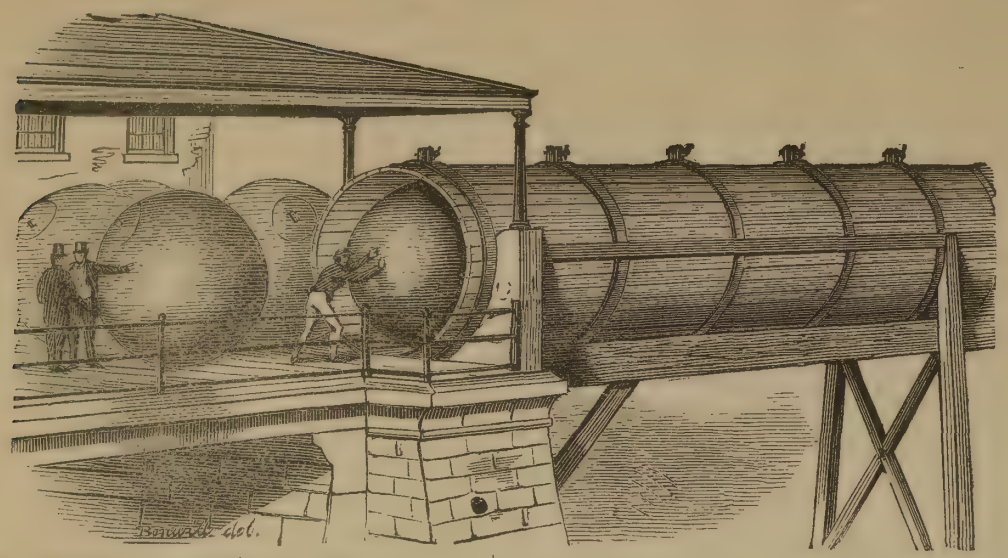
The sewers of ancient cities were intended to combine two of these objects, or the removal of all surface water and fæcal refuse. The early sewer works of England were designed for conveying away surface drainage only, which, as a rule, was passed by short lines of sewers to the nearest natural outlet. It was illegal, prior to the year 1815, to pass fæcal matter into sewers. Such matter was generally allowed to accumulate in cesspools, either under the habitations of the people, or in close proximity thereto; but the growing evils of this system were so great that, about the year mentioned, the laws which guarded sewers were by the tacit consent of the various authorities allowed to lapse. But it was not until the year 1847 that the first Act of Parliament was passed, which made it compulsory to pass fæcal and other matter of this character into sewers. Much difference of opinion has been expressed as to the mode in which the objects sought to be fulfilled by sewers ought to be carried out in practice. It may be taken as an ascertained fact, that no abstract rule universally applicable can be laid down for the guidance of the engineer in the prosecution of works of sewerage, although there are some general principles which are common and applicable to every town. Naturally there are conditions and circumstances which arise during the prosecution of sanitary works, and which differ in different places, which must guide the engineer as to the plan of sewerage he should adopt. In all sanitary works it should be laid down as a first requirement that the works shall be capable of fulfilling their sanitary mission. All questions relating to the pecuniary results that may arise from the profitable disposal of the matters to be dealt with, must be taken to be of secondary importance, although this question must not be entirely lost sight of.

The preliminary inquiry in a district will naturally embrace—

1st. The area of a district to be sewered.
2d. The rainfall of the district, and the proportion it is intended to admit into the sewers.
3d. The geological character and physical outline of the district.
4th. The present and prospective number of its inhabitants.
5th. The supply of water in the district.
6th. The sanitary appliances at present in operation, or to be adopted.
7th. The position of the outfall, and the mode of disposing of the sewage. [From a very thorough article in *Am. Architect & Building Journal.*]

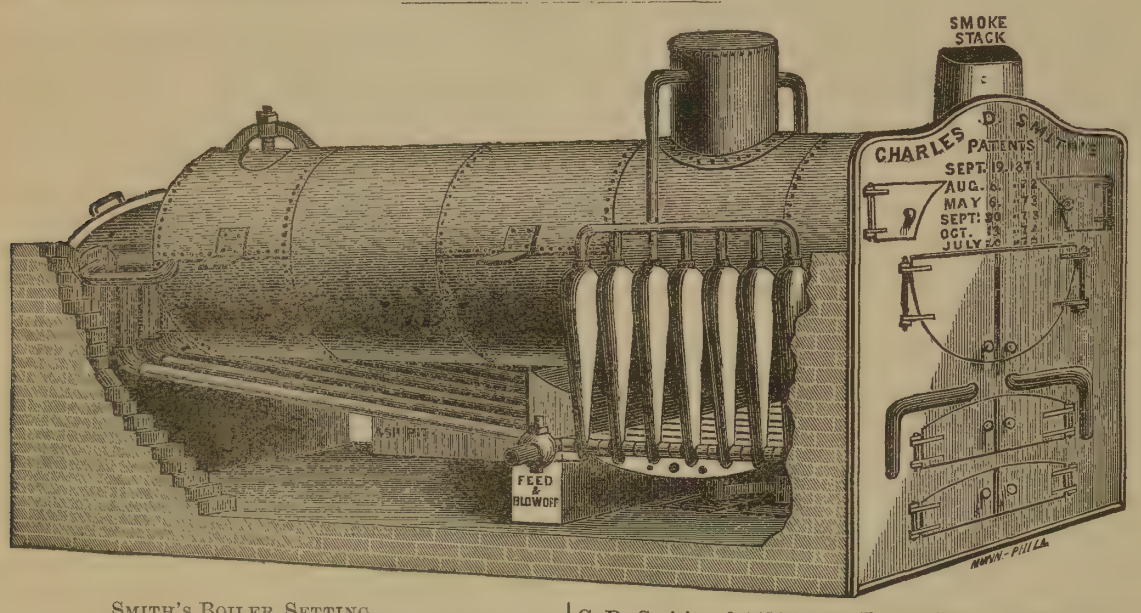
Two New Iron Steamships about to be commenced at Chester, Pa., at Roach's yard, will each be 292 feet long and about 2,400 tons burden. They are to be provided with water-tight compartments and three decks, and will be brigantine rigged. Each vessel will have a compound engine of 1650 horse-power. [*Iron Age*, Nov. 23, 1876.]

CENTENNIAL NOTES.



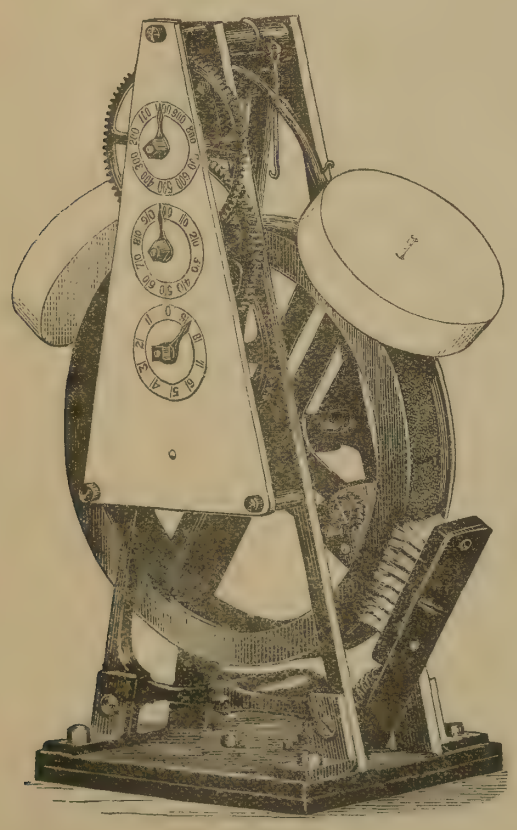
SYSTEM OF PNEUMATIC TRANSMISSION.

Mr. Chas. P. Gladwin, of 144 N. Third St;, Phila., showed his system of pneumatic transmission, which may be briefly described. Ordinary pneumatic tubes are employed, with forced blast or exhaust as desired; the messages or packages to be sent are enclosed in hollow *spheres* which should give great carrying power, with lightness, and a very small amount of friction, as their contact with the tube is a rolling one only.



SMITH'S BOILER SETTING.

The cut illustrates a mode of setting shown in model form in Machinery Hall, and also of full size in operation, by C. D. Smith, of 148½ South Fourth Street, Philadelphia, and claimed to largely increase the heating surface, steaming capacity, and economy of stationary boilers.



CLOTH TESTING MACHINE.

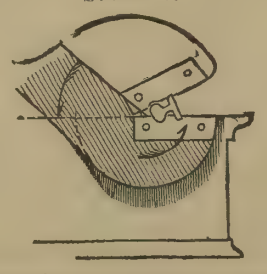
(Russian Section, Main Building.)

The cut shows a machine used by the Russian government to test the wearing qualities of cloth offered for army clothing. A sample of the cloth to be tested is placed upon the drum, which is rapidly revolved a given number of times as indicated on the counting dials. A stiff brush shown at the right is pressed against the revolving drum, with a force regulated by the weight seen above it. The friction of the brush simulates natural wear of the nap and substance of the cloth, and the appearance of fabrics after a certain number of thousand revolutions, indicates very nearly their comparative wearing qualities. G.

W. X. STEVENS' CENTRE-CUTTING SHEARS.

The inventor argues that an increase of leverage may be more economically obtained by shortening the arm of resistance, than by lengthening the arm of power. Carrying this principle to the extreme, he does away with the usual central bolt of shears, and brings the piece to be cut as near the centre as possible, making the revolving bearing around the cutting blades, as shown in the section view "O." This not only lessens the actual

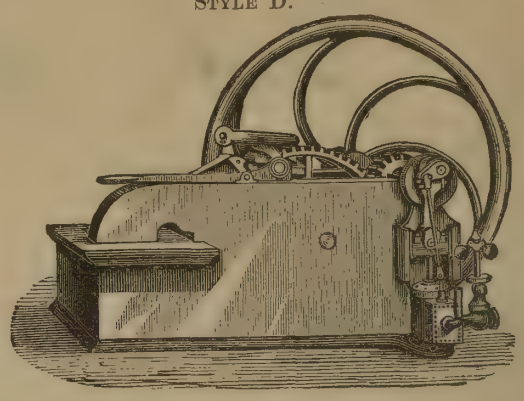
STYLE O.



strain on the machine in direct proportion to the lessened leverage of resistance, but it distributes the strain over a much greater bearing surface, making the machine very strong and yet very light.

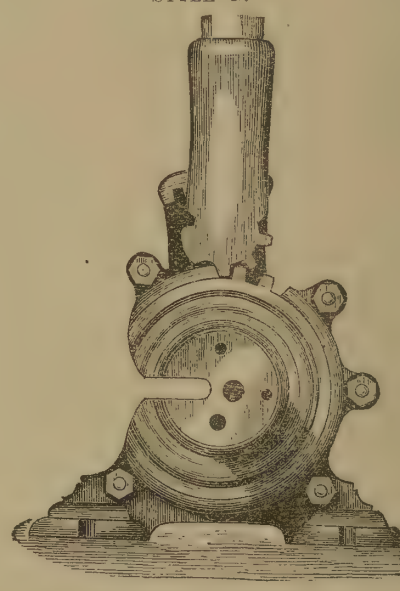
The W. X. Stevens Tool Co., of East Brookfield, Mass., which manufactures these shears, showed a variety of styles in the Centennial Exhibition, at Column B–34, Machinery Hall, style D running all the time. This occupies 2×7 feet of floor room, and weighs four tons, of which 1,600 lbs. is in the fly-wheel; and when run at full speed, requires six horse-power, cutting iron rails eighteen times a minute. Its stated capacity

STYLE D.



is to cut 7×2 flat, 3 in. square, or 4 in. round iron. It is also suitable, when so arranged, to cut 2-in. cable chain iron, on an angle suitable for welding. The power is communicated from the driving gears to the shear lever by means of an eccentric and ratchet, and is thrown on or off by a hand-lever. Time and power are used in going forward only: as the shear-arm drops when the piece is cut, and remains at rest until another piece is inserted and the lever pressed down, when it starts as before. Or it may be set to run continuously of itself.

STYLE G.



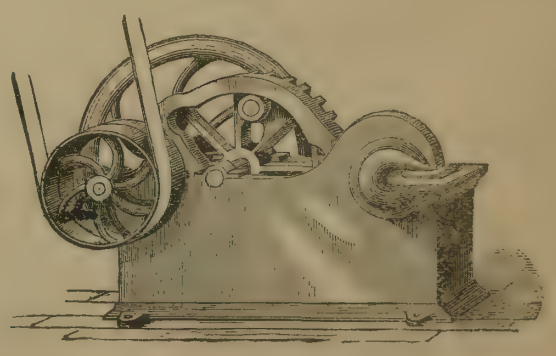
This prevents accidents and waste of iron. Style C has an open mouth, suitable for working up old crooked bars and junk, and its jaw runs all the time, as in the old style shear, resting only one quarter of the revolution to allow work to be put in. Both these styles cut with an upward stroke, thus preventing the bar from kicking, as it pries downward when cut. Style E is suited for cutting round or flat iron square off.

It is furnished with a peculiar gauge for cutting rapidly to a given length, for bolts, chain links, etc., and so arranged that the shear is standing with its mouth open until the bar is pushed against the gauge, when it starts instantly, and after cutting the bar, stops again. This shear is stated to cut round iron up to ¾-in., at the rate of 60 cuts a minute, and 2-in. iron at 12 cuts a minute, without any change of bolt or gears, by merely setting a stop pin. This is a valuable feature, economising the whole power of the machine on every size of work.

One style of shear is especially adapted for cutting merchant iron *square off*, and it leaves a neater end at much less cost of power and time than does the cold-saw or buz.

Hand-working shears were shown on the same general principle; their range being from wire to two-inch round shafting.

STYLE B.

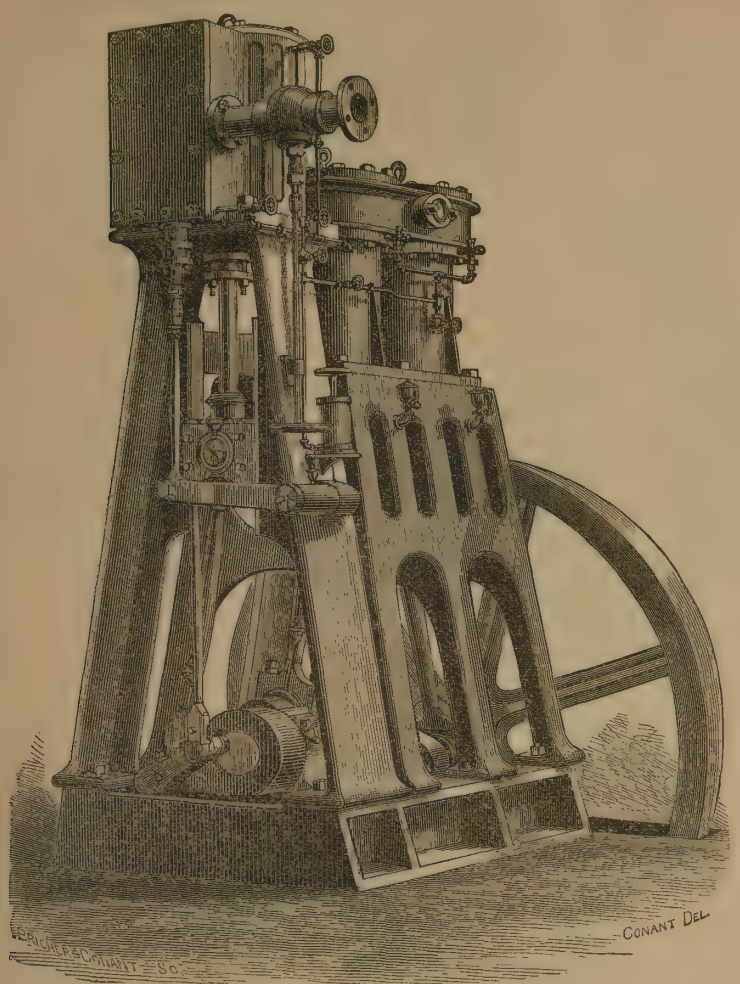


THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, DECEMBER 9 1876. NO. 23.



THE BURLEIGH AIR COMPRESSOR.

[Manufactured by the Putnam Machine Works of Fitchburg, Mass., for the Burleigh Rock Drill Co.]

The great utility of compressed air as a motor cannot be questioned. If it could be had as cheaply as water from the supply pipes of cities, it would be used for many purposes not now dreamed of, as well as for the many it is now desired for. Sewing machine motors, in every way unobjectionable, would no longer be a desideratum. It would be used for cooling purposes in place of ice, or ice itself could be produced with it. It would be in use for cooling the air in dairies, breweries, and meat-packing houses, or even for rendering compartments more comfortable in hot weather.

For transmission of power into mines and tunnels, for driving machinery, and for ventilation, it is already indispensable, and in quite common use at such works. Water and steam power have been used for compressing the air, but the latter is the only cheap power which can be employed under all circumstances.

The cut represents a Burleigh Steam Air Compressor which has been extensively used at mines, tunnels, &c. It consists of a double-acting upright steam engine, and two single-acting air-compressing cylinders; all taking action at one triplet crank shaft, situated on the strong bedplate of the machine, and directly under all the cylinders. The framework of the machine is massive, and of design especially adapted to resist the severe strains brought upon it.

The air cylinder cranks are at points 180° apart. The steam cylinder crank is not placed in line with them, but in such position that when the resistance to air compression is greatest, the steam pressure can act to overcome that resistance to the best advantage. When the steam is cut off at about from a fourth to a half stroke, the steam piston should be in the neighborhood of a third stroke when the air piston is at two-thirds stroke. In this way the flywheels may be brought to the minimum of weight.

For the engine no governor is required, as the speed in compressors should be determined by the rate of consumption of air. With fixed cut-off and uniform steam pressure, a nearly fixed air pressure is realized, whatever the rate of consumption of air, because of the necessarily nearly equal areas of strain and air indicator cards; so that the varying consumption rate is met by a corresponding change of speed rate. But the point of cut-off should be adjusted for each case in order to obtain any desired adaptation of steam pressure to desired air pressure. This is done by a most admirable arrangement, by which the steam may be admitted for any fractional part of the stroke. The valve-gear is the same as that on the Burleigh Automatic Cut-off Engine, made by the same firm, except in the fact that in the latter the cut-off is regulated by the governor, while in the former it is adjusted by hand. The valves are double beat balanced poppets, raised by small cams. The followers of the cams are levers upon which the valve-stems rest. By sliding the lever longitudinally, the time of its drop, or return on the cam, is varied, while the lift remains the same, and thus the duration of port opening is altered. These cam followers are connected by link-work to a band lever, accompanied with a graduated arc and pointer. Thus the point of cut-off can be read at a glance, and be varied at will or requirement.

The pistons of the air cylinders are provided with the air induction valves, which are annular poppets. In the upper heads are placed the eduction valves, by which the air escapes into a chamber, whence it is conducted to a reservoir, or to any place for its application.

The air, while in the act of compression, is heated at a certain rapid rate well known in thermodynamics, which, for a change from atmospheric pressure to 80 lbs. per sq. in., a not unusual pressure for these machines, would result in a temperature so high as to endanger the burning of the lubricants used in the cylinders. This is prevented by the injection of a spray jet of water into the air, at the proper moment to absorb, by the evaporation of the water, the heat set free by the compression.

This machine is so complete, and of such fine design and workmanship, that the areas of the steam and air indicator cards measure almost exactly the same, resulting in a very high degree of efficiency.

S. W. Robinson.

School of Mech. Eng,
Ill. Industrial University.

HYDRAULIC HOSE.

[This article originally appeared in the *American Exchange and Review;* was reprinted in *The Fireman;* and is republished by request.]

The contest between the Egyptian priests of Canopus and those of the Chaldean deity of fire resulted in a victory for Canopus; and ever since the Nile's mythologic day, Canopus has been about the sole victor over flame. Among the many contrivances for conducting water to the fire, we find flexible tubes early superseding the more cumbersome and inefficient pipes of metal, bamboo, wood, etc. Perhaps the first flexible tubes were ox-entrails, used to convey water to a distance, and in any desired direction, for the protection of forts from the darts. Still, the use of leather hose is certainly of very early date. Pliny related that the inhabitants of the island of Andros, one of the Cyclades, obtained pure water from the springs at the bottom of the sea, by sinking a leaden bell, to the top of which was connected a leather tube, which conveyed the water to the surface. About 1670, sewed hose of leather, and of canvas coated with paint or other compounds, was used in England, having been known on the continent for a considerable time previous. In 1672, the brothers Van der Heide, of Amsterdam, enterprising fire-engine builders, brought out sewed leather hose in 50-foot lengths, so fitted with brass connecting screws as to form a continuous line of any length when attached to the engine. In 1720, seamless hemp hose was made by Beck, a lace-weaver of Leipzig. Several other establishments manufactured this seamless hose, but their date is uncertain. In 1807 or 1808, Messrs. Sellers & Pennock, of Philadelphia, brought out riveted leather hose, which rapidly supplanted the sewed hose in this country, and in 1819 was introduced into England by the celebrated Jacob Perkins, inventor of the steam gun, etc. This had the advantage of being strong enough for ordinarily attainable water-pressure, and, if properly cared for, durable. A great disadvantage, however, was the offensive smell and foul grease with which it was essential to keep it constantly smeared or permeated, at great expense and trouble. Again, the bulk and weight were excessive; the rivets tore the hands and apparatus, and obstructed the flow of water; and the expensive and cumbersome method of repairing the constantly occurring breaches was another of the causes which led to the superseding of leather hose by that of rubber.

In 1827, Thomas Hancock, in England, brought out the rubber hose substantially as made up to the present day. This was formed on smooth cylindrical mandrels 50 to 60 feet long, which were coated with rubber, then wound with spiral layers of light cotton cloth, alternating with rubber. This hose had the merit of being smooth, regular, clean, and water-tight; and although it superseded the leather from its superior strength and other good qualities, it was heavy, bulky, expensive, impossible to mend,—and its durability was short, owing to the perishable nature of the large quantity of rubber entering into its manufacture. Again, from the spiral character of the

cotton "plies," there was a strong tendency to unscrew the couplings, and thus occasion loss by delay. But, perhaps the greatest cause of the condemning of four-ply rubber hose was the wide opportunity open for the employment of inferior cotton canvas, and for the excessive adulteration of the rubber layers. Competition ran down the quality even more rapidly than the price, until, at length, it was the endeavor to palm off anything that was round and hollow as a first-class article. Of course, against the excessive or deficient vulcanization or "curing" of the rubber there was no protection to the purchaser.

The great weight of the leather and rubber hose led to a new departure in manufacture—a combination of the comparative lightness of leather with the tightness of rubber. A heavy cotton fabric, coated on one side with rubber, was strongly riveted together, with the gum surface inside. The result was a hose rather lighter than leather, though possessing the objectionable rivets—requiring no oiling, but difficult to mend, and still too heavy to keep up with the constantly increasing exigencies of fire surface. A seamless woven hemp hose had previously been tried, giving, in its lightness and small bulk, excellent satisfaction, but failing, from the fact that it was not water-tight, and that, in order to get a strong fabric, choice was made of hemp, which was extremely susceptible to mildew, and rapidly deteriorated. To render it water-tight many plans were adopted, until at length a patent was taken out for lining the interior of a seamless canvas tube with a sheet of rubber. The choice of materials was again unfortunate; in the anxiety to provide a strong hose, linen was preferably used, and there was met an obstacle not yet surmounted—the impossibility of successfully working rubber in connection with linen. Again, the mode of applying the rubber lining was, and in the present state of the art continues to be, imperfect and unsatisfactory, inasmuch as it is possible, even in new hose of this class, to separate the plies; and, as months advance, the removal of the lining can be readily effected with the fingers, unaided.

Each, then, of the kinds of hose we have mentioned had some points in its favor which gave it partial advantage. A hose, to answer the conditions of unobstructed usefulness, must be light, strong, flexible, of small bulk, water-tight at 200 pounds pressure, durable, and easily kept in order. It is tolerably certain that lightness and strength combined can best be obtained by the use of specially woven canvas, which gives also a flexible hose of small bulk. To make this water-tight, rubber can be applied only by calendering it on the canvas before manufacture into a tube; the mechanical difficulties of so applying a rubber lining as to adhere absolutely and permanently, and to stretch equally with the canvas tube, being at present insuperable.

By calendering a coat of rubber into the pores of a canvas roll, and afterwards sewing or riveting into a tube, the body of the hose is tight, but the seam is apt to leak; while cementing or vulcanizing the edges together does not, alone, effect a sufficiently strong union. Rivets are expensive, and give an objection never to be surmounted, in their roughness to touch, their corrosion of the fabric (if they be of copper), and in the expense of repair. The makers of sewed hose have surmounted all the objections by making a strong seam through rubber-coated unvulcanized canvas, and tightening the seam by subsequent vulcanizing. By using cotton fabric, unsized and uncalendered, they secure a favorable material to work in conjunction with rubber. There is a novelty in fabric called the "Baker fabric," and its peculiarity is, that each strand or fibre is a three-ply cord, and the fabric is composed of a great number of plies interwoven, as in a carpet.

It is very questionable to claim merit for a hose in being double, and in having between the two linen tubes composing it a layer of unvulcanized rubber, as the property of this uncured rubber is to become viscous in warm weather, and brittle in cold, rotting at any season. To avoid the use of perishable rubber is surely a great *desideratum*. A step has been made in this direction, by so chemically treating closely woven canvas as to close its pores while mildew-proofing and strengthening the fibres. Whether the merits of this process may best be brought out by its application to seamless or sewed hose, is not yet ascertained.

The demands of fire-service for a hose in every way suitable to the exigencies of use are now not far from being fully satisfied. The extreme value of perfect appliances of this kind, for preventing wholesale loss by disastrous conflagrations, are being better appreciated each year.

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FIRE PROTECTION.

SELF-LIGHTING GAS BURNER.

[Stockwell Self-Lighting Gas Burner Co., 89 Liberty St., N. Y.]

FIG. 1.

We have frequently referred to the great number of fires caused by friction matches. The device illustrated herewith (Fig. 1) is intended to obviate part of this danger, and the trouble of hunting for loose matches. (This latter nuisance is done away with by another inventor, who very sensibly makes a match-box which surrounds the horizontal gas-fixture at its juncture with the wall.) The device here shown has a coil of thin paper tape (Fig. 2) upon which are little pellets of a percussion compound (claimed to be proof against all effects of moisture or temperature). By turning the key, the paper coil is partly unrolled, and a pellet exposed to the action of a spring hammer, which causes a flash and thus ignites the gas instantly. The cost of the tapes (each of which bears 135 pellets) is stated to be about the same as that of ordinary matches; and the percentage of failures to ignite is claimed to be less than with matches.

FIG. 2.

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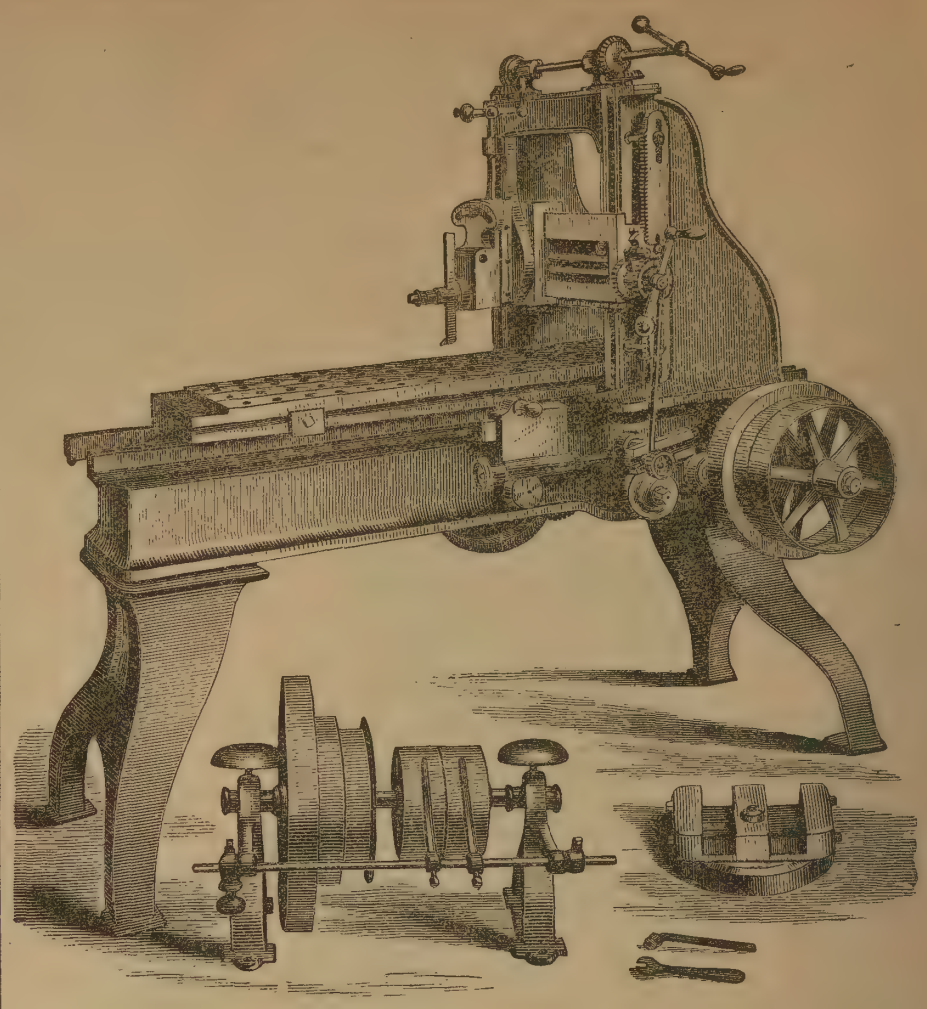

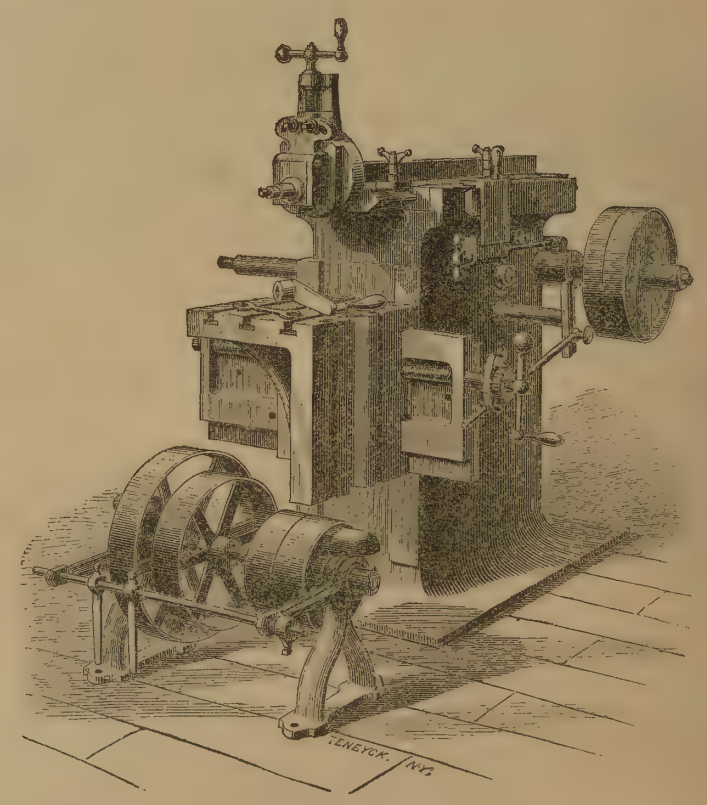

PLANER AND SHAPER.

[MADE BY THE HENDEY MACHINE COMPANY, WOLCOTTVILLE, CONN.]

These machines are operated by a mechanical movement having for its object a quick and decisive reversing motion; by means of a friction clutch working between two loose pulleys running in opposite directions to each other.

This clutch is made to engage either pulley by a slight movement along the shaft caused by a partial rotary movement of a cam box with a diagonal slot in it working on a fixed stud secured to the box in which the driving shaft runs. This cam box has a connecting rod attached to it and extending forward to a slide upon the front of the machine, which, in turn, is driven either way by means of a stop block on the *edge* of the planer table and on the *top* of the shaper on the slide. (See cuts of the machines.)

The advantages of running an iron planer by means of such a clutch are numerous. One of these is to obtain a short accurate stroke, so positive as to carry the tool to an exact point under all circumstances, whether cutting light or heavy chips. This principle is especially appreciated in operating the shaper, for besides that accuracy which it needs is common with the planer, there is a great advantage in the ease with which the stroke is regulated by the operator while the machine is in motion, a feature not obtainable in the ordinery crank planer. This shaper is recommended by one other essential feature—its long uniform stroke and the steady speed of the cutting tool.

These machines were shown in Machinery Hall.

The Polytechnic Review:

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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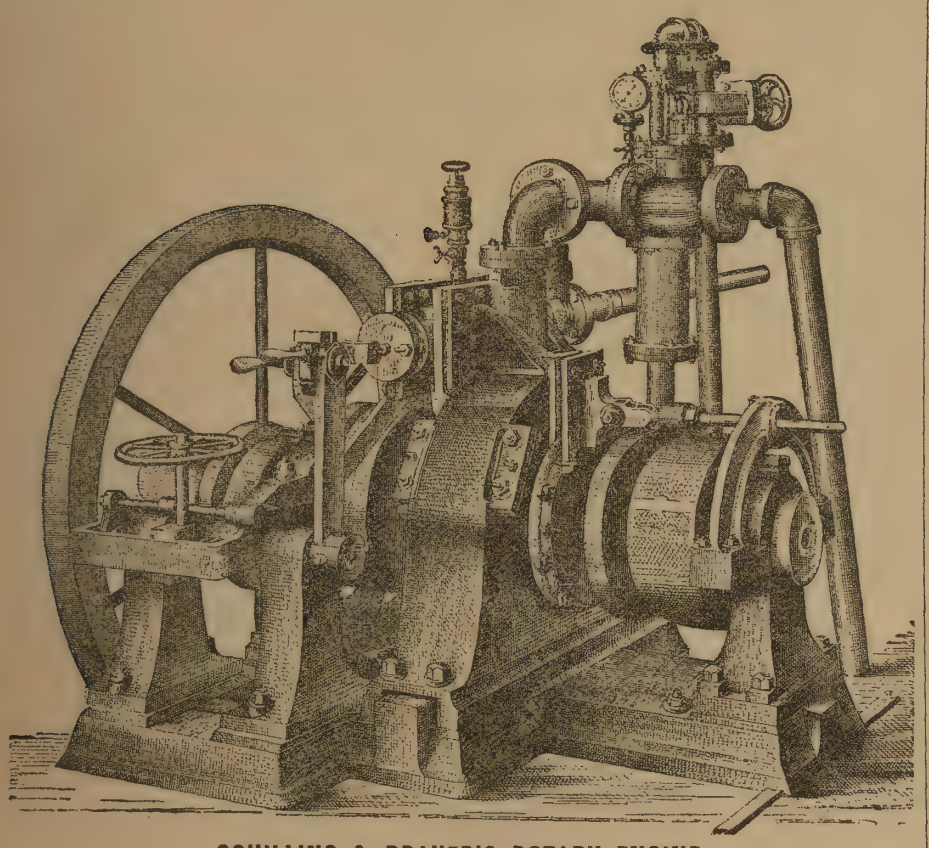
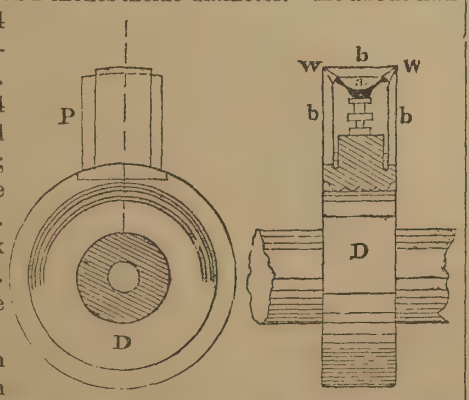
OUR NUMBER FOR DECEMBER 23D will be given an unusually large circulation among manufacturing establishments interested in the question of Lubrication, as partially treated by Prof. R. H. THURSTON, in an article specially prepared for us by him. At least 5,000 manufacturing establishments, over and above those on our regular lists, will be mailed, each, a copy of the number mentioned. Our last number was sent to 3,600 saw, shingle and planing mills, in addition to our regular list.



SCHILLING & BRAUER'S ROTARY ENGINE,

WITH VARIABLE CUT-OFF, REVERSING GEAR, AND KÖRTING'S EJECTOR-CONDENSOR.

This engine has a cylinder 26 inches diameter and 4 inches width. The shaft is of cast-iron and hollow, of 5½ inches outside and 2 inches inside diameter. At about half length is a disc D, 14 inches diameter and 4 inches wide, into which the piston P is recessed, and secured by two 1-in. screws. Each of the cylinder ends has a hole of 14 inches diameter, into which projects a gland having a neck of 12-in. outside diameter; fitting steam-tight on this neck, and into the 14-in. hole in the cylinder, is a ring, 1-in. thick, pressed against the disc D by six springs, which can be adjusted by six ⅜-in. set screws, tapped into the flange of the gland.



The piston P is of cast-iron, fitted with three cast-iron packing plates b b, which are adjusted by springs and wedges; the side packing plates are kept against the cylinder by small spiral springs at their lower ends, their upper ends being pressed outward by the wedges W, these latter also forcing the top packing plate against the circumference of the cylinder.

A flat spring A, adjusted by a set screw, presses the wedges W diagonally outwards, thus keeping both the side and top packing in contact with the cylinder.

Admission, exhaust, and cut-off of steam are regulated by a common D valve, working on an ordinary valve face with two steam ports, and one exhaust. The horizontal valve stem is connected to a vertical lever on a rock shaft, that carries two other levers whose ends are situated respectively above and below a series of cams on the main shaft. These levers can be shifted on the rock shaft by a vertical spindle with a small pinion on its end, gearing into a rack, connected with the above named levers; thus they can be brought into contact with any two cams (one working the lower, the other the upper lever) to effect the required cut-off.

To obtain steam pressure on one side and vacuum on the other side of the piston, the abutment slide is introduced across the cylinder. Steam is admitted between it and the piston, vacuum or exhaust being on its other side. When the piston has moved round to the other side of the abutment, it is withdrawn, the piston passes, the abutment is again inserted, and steam between it and the piston drives the latter on again.

The movement of the abutment is effected by a small brass roller, on a pin fixed to its guide rod, gliding along a curved grove in a disc on the main shaft.

The abutment consists of two plates, one having a projecting ring, fitting into a recess of the other, leaving a hollow space, into which a spring or steam is introduced; thus keeping them in contact with their faces, so that no steam can pass by.

When the engine turns to the left, the left port only is used for steam, the right being connected with the exhaust; when turning to the right the opposite takes place. To reverse the engine thus necessitates a change of the position of the valve, and this is done by an eccentric pin, inserted into the forked end of the vertical lever connected to the valve-stem. This pin has a handle, which on being turned through 180°, effects the desired change in the position of the valve.

The condenser is Körting's patent ejector, requiring no air-pump; takes up little space, and gives a vacuum of 21 to 26 inches.

Opening the direct exhaust and shutting off the injection water, changes the engine into non-condensing.

Tests made with the engine at the Exhibition have shown, that the described packing makes a perfect steam tight joint, and that the friction of the entire mechanism is exceedingly small. With the condenser at work the engine made at one time 60 revolutions per minute, which, on working non-condensing were reduced to 35, showing the work of the vacuum to be 41 per cent. of the whole.

Working non-condensing, with 75 lbs. of steam, at 75 revolutions per minute, a trial by dynamometer gave 12 horse-power; the consumption of water (calculated) cutting off at half stroke, was 411 lbs. per hour, which, taking a rate of evaporation of 9 lbs., would give $\frac{411}{12\times9} = 3{\cdot}8$ lbs. of coal per horse-power per hour. When condensing, the horse-power might be about 16, giving $\frac{411}{16\times9} = 2{\cdot}85$ lbs. of coal per H.P. per hour, which is certainly a very low consumption for a class of engines generally considered wasteful of steam.

JOHN HAUG, C. E.

THE INDUSTRIAL APPLICATIONS OF GRAPHITE.

But few of the natural products of the mine possess a greater interest to the utilitarian, because of the number and variety of its applications in the useful arts, than graphite. It may be of value, therefore, in view of the general want of familiarity with the history of this mineral, the properties that make it valuable, and the sources of its occurrence, to present in the pages of the REVIEW, a summary of the leading facts bearing upon the points in question.

Mineralogically defined, graphite is one of the allotropic modifications of carbon, and is likewise called plumbago and black lead, or (when quite impure), carburet of iron. It is frequently found distinctly crystallized, in flat six-sided tables, belonging to the hexagonal system, and like mica, having a most perfect basal cleavage. It is one of the softest of minerals, possessing a metallic lustre, and a color varying between iron black and dark steel-grey. It leaves a black and shining mark, or streak, behind it when rubbed upon a surface of white paper or porcelain. Like all substances possessing metallic lustre, it is opaque; it is greasy to the feel, and when in laminæ, quite flexible. It usually contains a variable percentage of iron, which is mechanically mixed with the carbon to the extent of two per cent. and upwards. It is infusible before the blowpipe, and is quite unaffected by acids, and at an extremely high temperature burns without flame or smoke.

Geologists, with one accord, agree in pronouncing it to be of vegetable origin, and in affirming it to have been originally a vegetable *debris*, which, by the slow action of natural causes of change, has simply undergone a more advanced and decided metamorphosis than coal. From the extent of this metamorphosis, therefore, the constant association of graphite with the older (and generally the oldest rocks) will need no explanation. From Dana (see his System of Mineralogy, ART. Graphite), we learn that the mineral occurs in beds and imbedded masses, laminæ or scales, in granite, gneiss, mica, slate, crystalline, limestone, and ancient sandstones; and also that it is sometimes found associated with deposits of coal, a fact that points very clearly to its vegetable origin.

It occurs in many parts of the world, and in considerable quantities; but the number of localities where it is found sufficiently pure for certain uses, is quite limited. For a number of years, a graphite of excellent quality was mined at Borrowdale in Cumberland, England, where it formed nests in a trap rock. This deposit* was discovered in 1564, and the material was locally known as wad. This mine gave England, for a considerable period, a monopoly of the articles made from the finest grades of graphite, and in order to keep up the price of these commodities, the amount taken annually from the Borrowdale mines was strictly limited. At the present these mines are no longer worked, having been for some time exhausted. Deposits of limited magnitude likewise occur at the following localities in Europe:—at Glenstrathfarrar in Invernesshire, where it forms nests in gneiss; at Arendal, in Norway, where it is

*See Knigh 's Mechanical Dictionary; *Art.* Pencil, p 1657, *et seq.*

found disseminated in quartz; at Pargas, in Finland, and in various parts of France, Russia and Austria. At Craigman, in Ayrshire, it occurs in coal-beds.* It is found in large quantity and of great purity in the island of Ceylon, and in Siberia. In this country it is found at Sturbridge, Hinsdale and other localities in Massachusetts; at Cornwall; at Ashford in Connecticut; at Brandon, Vermont; at Ticonderoga, New York; at several localities in Bucks County, Penna.; at Wake, North Carolina; Spartansburgh, South Carolina; at St. Johns, New Brunswick, and at several localities in the Ottawa region in Canada. At the present time, the fine grades of graphite, known in commerce by the trade-name of plumbago, are obtained from Ceylon; Siberia; Canada; and Ticonderoga, New York. Inferior grades of graphite, under the commercial name of "black lead," are obtained principally from Germany.

Graphite is used for pencils; for crucibles or melting-pots for the smelting of metals, steel making, etc.; as a lubricant for the running parts of machinery, and generally for diminishing friction; in electrotyping, to form a conducting coating upon the cast of wax, plaster, etc., to be copied in the battery; as a paint, generally for objects exposed to the weather; as a stove polish, in various mixtures; in glass making, for coloring dark glasses; for glazing gunpowder, shot, etc.; for various refractory mixtures; in the manufacture of felt hats, to give softness and smoothness to the touch of the fabric; and for a variety of less important uses too numerous to specify.

The earliest use of graphite for drawing lines or letters is mentioned by La Moine, who cites a document of 1387 ruled with graphite. The ancients employed "styles" of lead or alloys of lead and tin; hence the names of plumbago and black lead which are yet (but improperly) applied to graphite, which subsequently took the place of the lead-style for drawing or marking purposes. Knight† records that slips of graphite in wooden sticks (pencils) were mentioned in 1565 by Gesner, of Zurich, who credits England with their manufacture. "In the early part of the 17th century," he further remarks, "*black-lead* pencils are distinctly described by several writers. They are noticed by Ambrosinus, 1648; and spoken of by Pettus in 1683, as enclosed in fir or cedar" * * * * "When Cortez landed in Mexico in 1520, he found the Aztecs using graphite crayons, which were probably made from the mineral found in Sonora." The earlier method of manufacture consisted simply in cutting or sawing the blocks of the mineral into the required shape and such lengths as the size of the block permitted, and using it in its natural state. Subsequently the strips of graphite were covered with wood, forming the lead-pencil as we know it. The process of manufacture as described by Knight, (*loc. cit.*) consisted in laying the prisms of graphite in grooves made in strips of cedar, causing it to adhere by a little glue, laying over it, and glueing on another strip of cedar, and finally shaping the pencil with a round-soled plane. The threatened exhaustion of the famous Borrowdale mine originated attempts for the utilization of the refuse, which, for a time, was pressed into blocks after suitable purification, but the leads made by this process were fragile, and this plan was shortly abandoned for the greatly improved method of Conté, now universally employed, and which possesses the great advantages of affording leads not only of uniform character, but also of different grades of hardness. This method consists in "making a mixture of graphite and clay, pressing it into the required shape from a mass like dough, and baking it into the required hardness for use." It may be of value just here to introduce a description of the method of manufacture followed by the leading establishment in this branch of industry in this country—the Joseph Dixon Crucible Company, of Jersey City,‡—in the production of "Dixon's American Graphite Pencils." The process is thus described by Mr. Orestes Cleveland, president of the Company:§

"The present method consists in selecting the best granulated plumbago (obtained from the Company's mines at Ticonderoga, New York), pulverizing it very finely, and floating it in water through a series of vats, the coarser particles settling to the bottom of the first vat, the finer in the next, and so on, till after passing through several, that which settles in the last vat is considered fine enough for the purpose. A suitable clay is found as yet only in Germany, and this is treated to the floating process, the finest only being fit for use. The plumbago and clay are then mixed together with water to the consistency of cream, and ground together as in grinding paint. When this operation is completed, the mass is plastic, water enough having evaporated to leave it in that state. It is then placed in a press and forced through an opening of the size and section desired for the pencil leads, and the leads are cut to a suitable length, straightened, and dried. When dry enough to handle, they are placed in a crucible, the air excluded, and subjected to a high heat, which bakes them and brings them out ready to be placed in the cedar for pencils. The different grades are produced by the different mixtures of clay and plumbago; the more clay the harder the grade produced. Skill in the manipulation, the exercise of great care as it progresses, and an expert to select the raw materials, are absolute pre-requisites for a perfect product. The next step is the preparation of the wood. Only a soft, close-grained wood will answer, and the best is the Florida cedar. The wood is sawed into pieces of the right length for a pencil, of a width suitable for six, and of half the thickness of pencils"

"These blocks run through a machine that planes and grooves them, the grooves being the depth of half the size of the leads. The leads are then laid into the grooves of one piece, while the other piece of cedar, exactly like it, is coated with glue and laid on the first. These double pieces or blocks are then placed in a press, many of them together, till dry enough to proceed. Leaving the press, they are solid blocks containing six leads equi-distant from each other, ready to be shaped into six pencils, and these blocks go through the first machine, that brings them to size, and then through the next machine, similar to a molding-cutter, coming out six pencils from each block."

"The machine for shaping turns out the pencils from the blocks at the rate of 72 per minute, or over 43,000 per day. The varnishing and coloring of the surface is done by a machine at the rate of 120 per minute, or 72,000 per day, and they are polished by a machine at the rate of 106 per minute, or over 63,000 per day. All of these machines are attended by girls, about 12 years of age, one to each, no skilled labor being required."‖

For the production of crucibles, melting pots for smelting metals, steel-making, etc., only the finer grades of plumbago are employed. The material finely pulverized is thoroughly mixed with clay, (that obtained from the neighborhood of Mayence on the Rhine, being the best yet known for this purpose). The proportions of clay recommended is the smallest quantity that will suffice to hold the particles of plumbago together, its only functions being that of a cement. After thorough mixture has been effected, the mass is turned into proper shape on a potter's wheel, set aside to dry, and finally baked in a kiln. When used for brass, copper, gold, silver, or metallic alloys, a good pot may be expected to stand from twenty to forty meltings; for steel meltings they require to be made of the best materials, and with the greatest care, and will run from four to six heats, according to qualtity and the care with which they are used.

As a lubricant for the rubbing surfaces of the machinery, etc., such as metal bearings, journal boxes, and especially for sliding surfaces under great pressure, as in planers, etc., graphite takes a high rank, and is greatly esteemed. For this purpose, however, none but the very choicest lumps should be selected from the best grade of graphite, and these then pulverized until the particles no longer glisten. The best makers recommend the separation of the pulverized mineral by floating on water, in order that it may be obtained sufficiently fine, while at the same operation, it may be freed from iron or spar or other impurities by treatment to a bath of dilute sulphuric acid. Mr. Cleveland's remarks on this point are so practical that we reproduce them in his own words:—

"There is no purpose, except for electrotyping, for which plumbago should be as pure and as fine as for lubricating; but a large part of that which is offered for sale as a lubricator is adulterated, some of it being composed mainly of the German black lead, and is of no more use than common clay for the purpose. For blowing cylinders, the best quality of Ceylon, pulverized to the finest grade, pure and left with a good body, is the most economical. For engines, rolling-mills, and machine-bearings, the very finest should always be used. For wood bearings, after oiling with the plumbago a few times, the oil can be dispensed with, and the pure plumbago only applied in a dry powder. For metal bearings it should be freely mixed with oil. On hot axles or journals apply it freely dry, and then oil up as usual. If the railroads would all use the best grade of Ceylon plumbago, pulverized and prepared as described, hot journals would be very rare, and much delay and loss in freighting saved, as well as annoyance to passengers avoided. No substance is known that is so useful for lubricating as plumbago, and yet although used for that purpose more than two hundred years ago, the true method of preparing it was not known till within a few years, and it comes upon the market now little understood, and almost like a new material. It is destined to work great changes. Mixtures and quack nostrums are sold with sounding names, but the plumbago in them is all they contain of the least value, and it is better to use it pure."

For the purposes of the electrotyper, who covers with graphite the face of the wax or plaster-mould he wishes to copy, in order to give it a continuous and good conducting surface, which shall take evenly and perfectly the metallic deposit, from the battery, it is obvious that the graphite must be as nearly as possible chemically pure, and in the finest state of division that can be obtained, and the smallest appreciable adulteration, or coarseness of grain, would render it entirely unfit for this purpose. In preparing graphite for electrotyping, none but the most carefully selected lumps are employed, and the separating and purifying processes first described are conducted even with greater care. As a stove-polish graphite, and mixtures containing it, are largely employed. For this purpose, it need hardly be added, the purer the graphite, the better. It is also used in powder mills for giving polish to gunpowder, and for polishing shot, for both of which uses it is necessary that it should be of the best quality.

As an ingredient of paint, graphite has long been used, and from its perfect indifference to the action of the elements, and its fire and water-proof properties, its value is very manifest. Mixed with fire-clay, &c., it is used in the preparation of refractory mixtures in metallurgy; by glass-makers, for coloring dark glass, for carboys, bottles, etc.; by hatters, for giving a peculiar tone to the colors, and smoothness to the touch of felt hats; by moulders, as a facing for moulds in making smooth castings such as stove plates and the like; as the important constituent of fire-proof inks for writing or printing on incombustible paper; and doubtless for a variety of other uses of lesser importance.

W.

Vide Dana System of Mineralogy, *loc. cit.*

†Am. Mechanical Dictionary, *loc. cit.*

‡This Company is the originator of the graphite industry in this country, and is doubtless the largest miner, manufacturer and dealer in graphite in the world. The Company has created the industry it represents, owns its mines, sells the raw product, and manufactures it into everything it is known to be useful for.—ED.

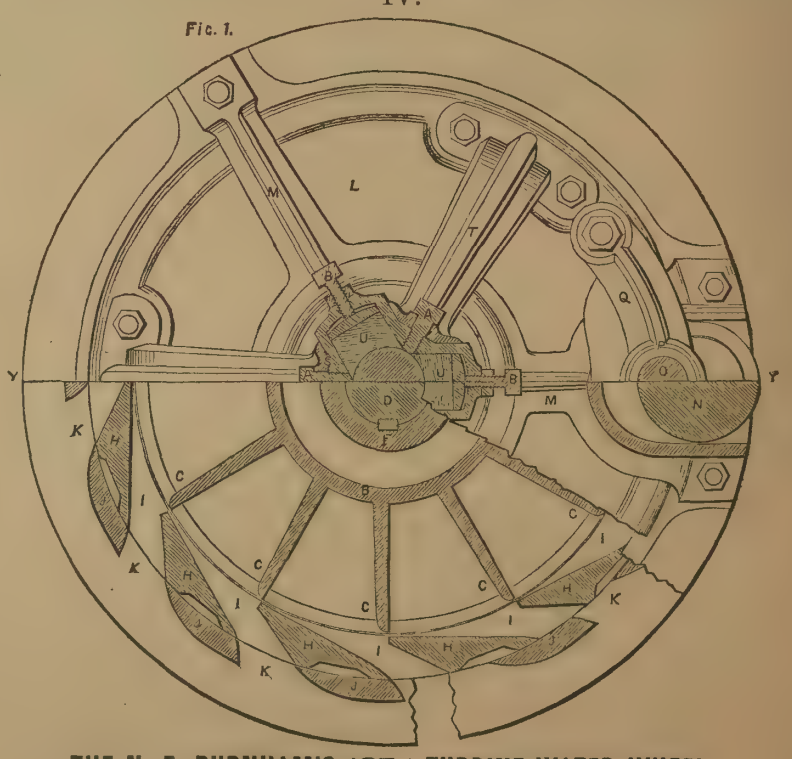
§*Vide* "Graphite, its uses and how to use it."—Cleveland, p. 12, *et seq.*

‖Knight's Mech. Dict. *loc cit.*

TURBINE WHEELS AT THE CENTENNIAL EXHIBITION.

IV.

Fig. 1.



THE N. F. BURNHAM'S 1874 TURBINE WATER WHEEL.

Manufactured by N. F. Burnham, at York and Christiana, Pa. Office at York, Pa.

This wheel is the result of upwards of eighteen years of experiment and improvement connected with the manufacture and introduction of the turbine wheel by this

firm. This extended experience and close observation of the thousands of wheels turned out during the period named, each keeping pace with the improvements of its day, furnished especial qualification for undertaking the final improvements combined in the "1874 *Turbine Water Wheel.*"

This wheel is of simple construction, as well as efficient in action; the later form having not only raised the percentage, but reduced and simplified the parts. The essential parts are the wheel in one piece, the chute case, the gate ring, the cover, the upper bearing, step and bridge-tree. These are well shown in the illustrations. Fig. 1 shows several partial horizontal sections taken along the line FF of Fig. 2.

Fig. 2

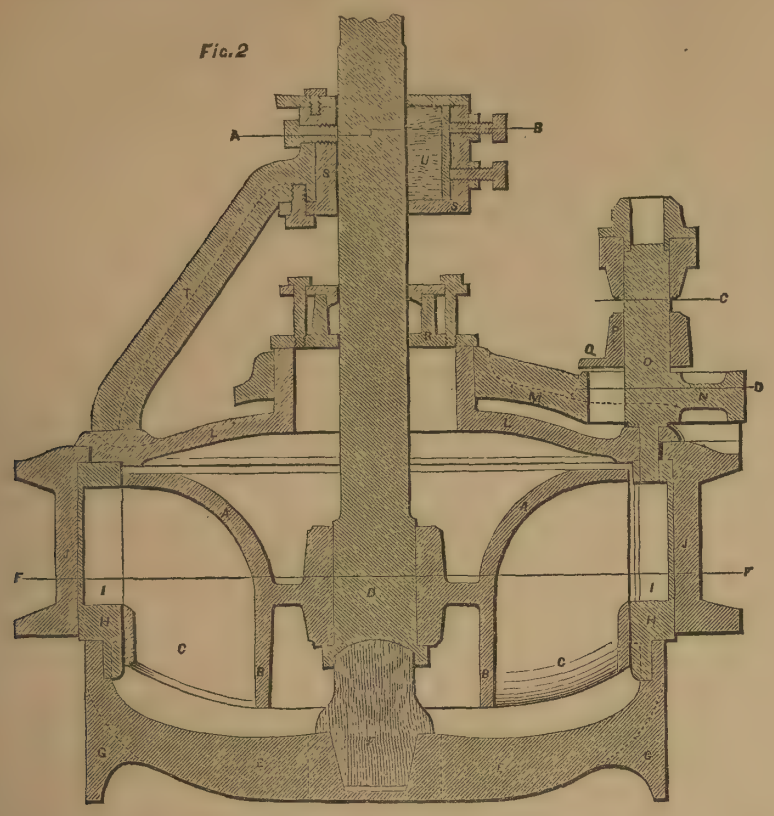


Fig. 2.—A B C is the wheel, which also is shown by itself in Fig. 3. The parts AB, forming the upper and inside limit of the inter-float spaces, is curved downward so as to give an easy deflection to the water from the horizontal direction where received, to the vertically downward at the exit. The chute case, H, has secured to it the bridge-tree, the latter supporting the wooden step and also the turbine itself. When desired, the projections, G, serve as legs to keep the turbine in position when it rests on sheeting or on a stone foundation.

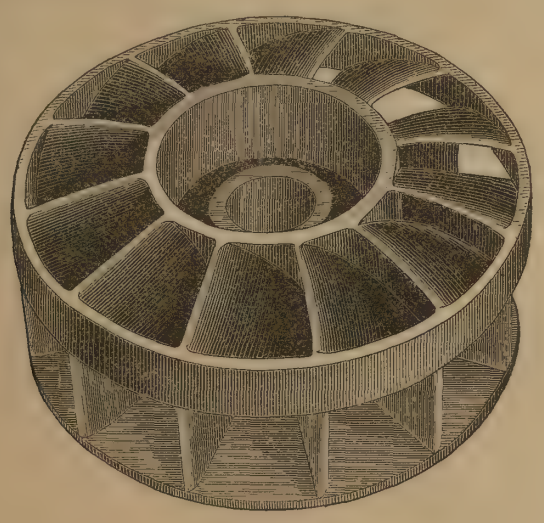


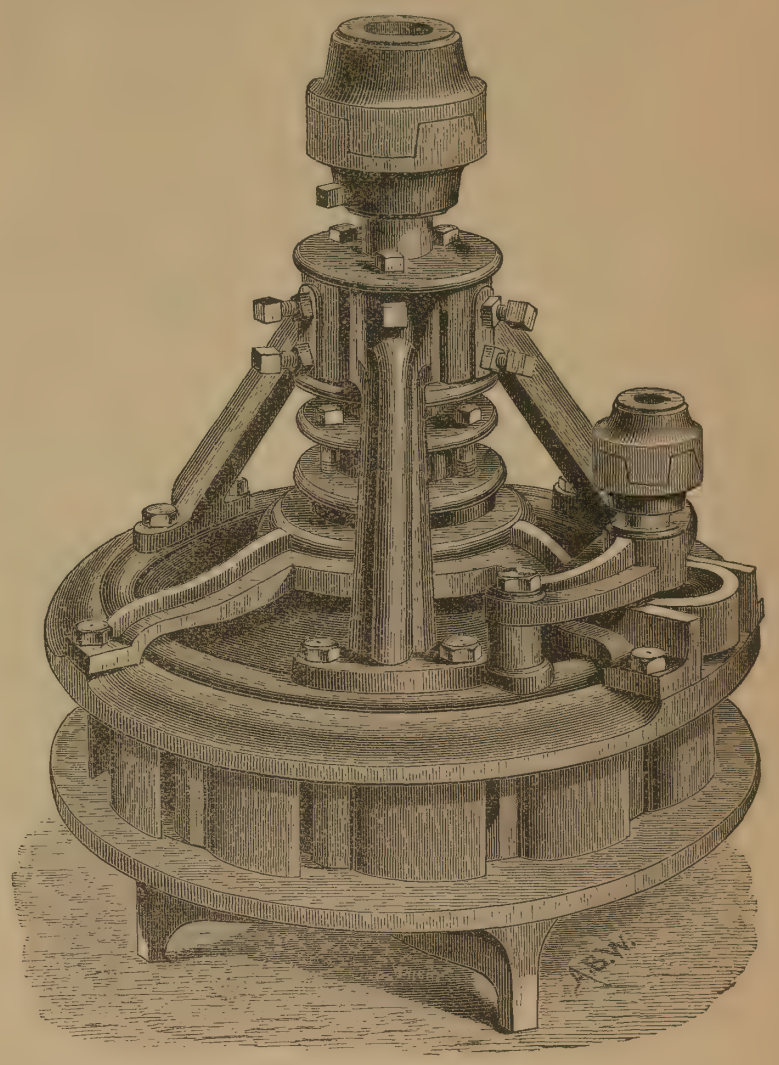
Fig. 3.

The cover, L, is secured to the top of the chute case, water-tight, and at the centre is raised in a neck, at the top of which is placed a packing box to prevent leakage down the shaft. The bottom of the flume closes around the turbine just below the lower flange of the gate ring, and thus it is seen that the water is effectually cut off except at the chutes.

The rotary or "register" gate, J, has openings corresponding with those in the chute case; and, for the open gate, form the prolongations of the chutes. For partial gate, the chutes are all partly covered by the shifting of the gate ring. This gives what may appear to some to be an unfavorable form of water passage, while, in fact, its effect at the narrowest point is much like that of an orifice in a thin partition, which gives the highest known velocity of projection; and velocity, as has been shown in a previous article, is the thing required in turbines. This orifice, if it deviates from the form named, it is toward the *vena-contracta* shaped mouthpiece, which, it is well known, gives nearly the same velocity. If it can be shown that the elongment, in effect, of the passage between this partial closure and the wheel, due to the presence of the full width chute in case H, has no influence to retard the water while traversing this chute space, the register gate must stand as one of good form. Indeed these passages, for all openings, have the form resembling the mouthpiece above mentioned, considering the influence of the passage upon the water as ceasing when either side terminates. One favorable feature of chute case is found in the fact that the sides of the blocks H, between chutes, converge nearly to a sharp edge on their inner terminations; so that the streams of water here have no chance to back up to fill vacant spaces.

The gate-ring is hung by a spider, the latter having a true central bearing on the neck of the cover above mentioned. This gives freedom of rotation of gate. The rotary movement for opening and closing is imparted to the ring and spider by means of an eccentric, N, embraced by a fork formed on one of the spider arms. The space behind the eccentric is covered by a web extending from the upper bearing of the eccentric shaft, so as to prevent the eccentric movement becoming blocked by obstructions. This movement for operating the gate, it is observed, is free from liability to annoyance arising from breakage of gearing teeth so common on turbine gates, and which, to provide against breaking, are sometimes made of steel castings.

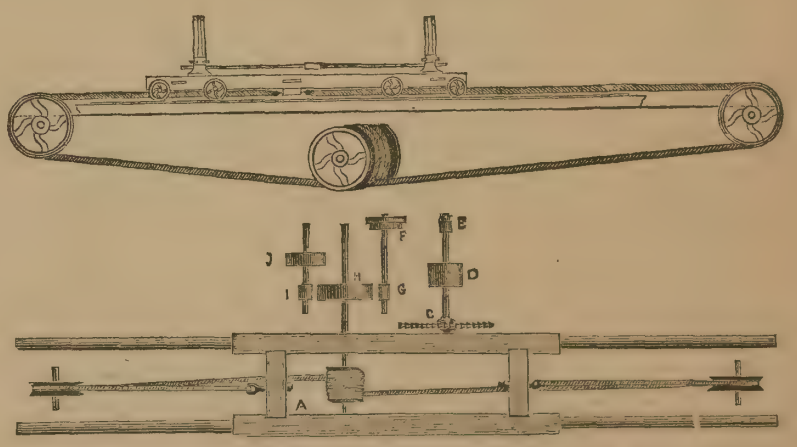
One good point about this wheel is the supporting of the upper bearings of shaft on a bracket connected firmly with the wheel cover and case, as shown in Fig. 4; and thus preventing the forcing into it of sand by the water pressure, as would follow if the bearing were on the neck of the cover.



These wheels, we are informed, give entire satisfaction in use, the "New Turbine," the form preceding the "1874 Turbine," having been selected by the U. S. Patent Office for raising water to the top of the building; and by the Japan Commission as a sample of American turbines.

S. W. ROBINSON.

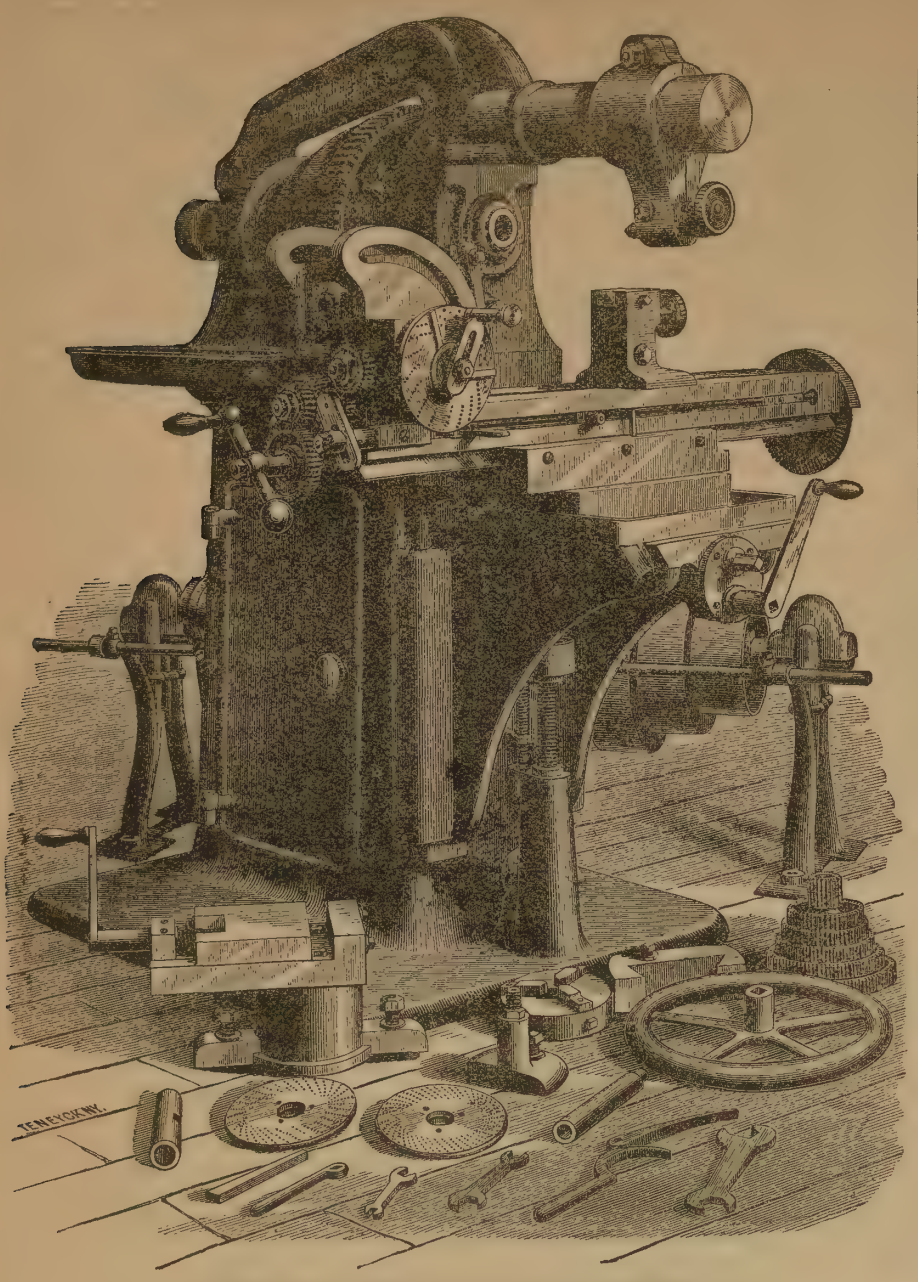
Dep't of Mech. Eng., Illinois Industrial University.



WIRE ROPE CARRIAGE MOVEMENT FOR SAW MILLS.

The cuts show a device for feeding and gigging back saw mill carriages, and are self explanatory. The rope is of steel wire, from one half to one inch in diameter, according to the size of the mill. The maker is Willard Lamb, Green Bay, Wis.

To SUBSCRIBERS.—If you will have the goodness to indicate in what respects this journal gives most satisfaction, and in what it fails to meet your approbation, you will aid us greatly in the publication of a journal which shall, so far as is possible, please all who read it, and profit all who advertise therein.



LARGE SIZE UNIVERSAL MILLING MACHINE,

MADE BY THE BROWN & SHARPE MF'G CO., PROVIDENCE, R. I.

This machine has been designed especially to meet the wants of steam engine and locomotive builders, and others engaged in the manufacture of heavy machinery.

It has all the movements of a plain milling machine, and the following in addition :—the carriage moves and is fed automatically, not only at right angles to the spindle, but at any angle, and can be stopped at any required point. On the carriage, centres are arranged in which reamers, drills and mills can be cut either straight or spiral. Spur and beveled gears can also be cut. The head which holds one centre can be raised to any angle, and conical blanks placed on an arbor in it, cut straight or spiralling. Either right or left hand spirals can be cut.

The cone has three diameters, each 3½ in. face. In addition, the cone is strongly geared, thus making six changes of speed. There are, also, the same number of changes of feed. The spindle boxes are of hardened cast steel, and, together with the spindle bearings, are carefully ground, and are provided with means of compensation for wear. The spindle will carry a cutter arbor projecting 15 inches, which is supported by an adjustable centre at the outer end. Cutters of 8 inches or less diameter can be used. The horizontal movement of the spiral clamp bed upon the knee in a line with the spindle of the machine is 6½ inches, and the vertical movement of the spiral bed centres below the spindle centres is 8¾ inches. The spiral bed can be set at angles of 35° each way from centre line of spindle, and can be fed automatically 22 inches, taking also 22 inches between the centres, and will swing 11½ inches. The hole through the chuck and spiral head is 1½ inches. The vise jaws open 3⅜ inches, and are 6 inches wide and $1\frac{5}{16}$ in. deep. Accompanying the machine are change gears for cutting spirals, index plates, Horton's special chuck, hand wheel, stop, rest, collet, wrenches, together with complete overhead works, with adjustable self-oiling hangers, shipper stud, stop, &c.

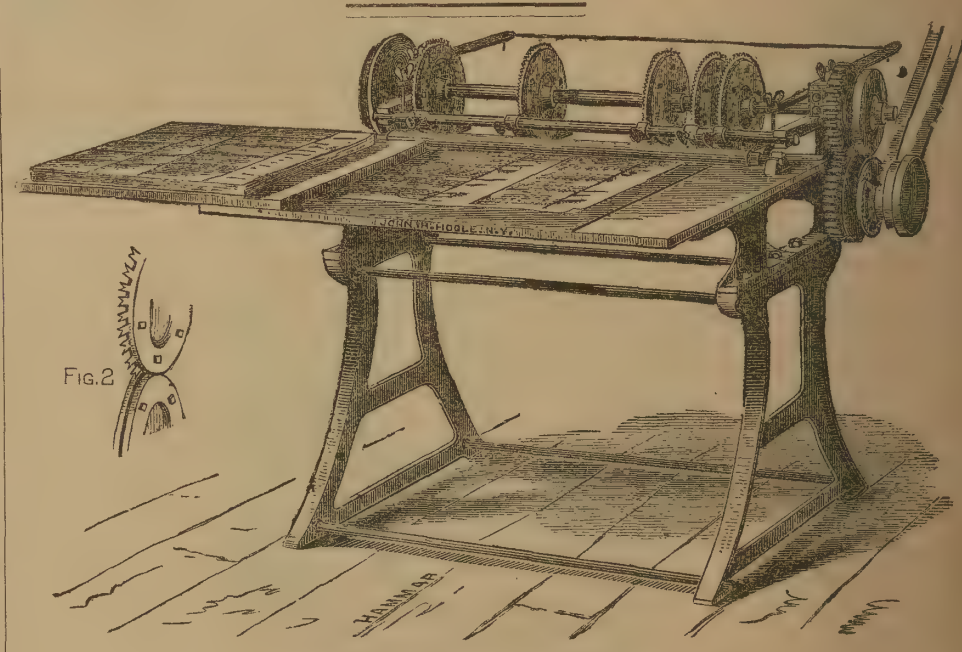
The pulleys on the counter shaft are 16 inches in diameter, and the whole width of the three equals 22½ inches. The counter shaft should run 105 turns per minute. The weight of the machine complete in one box is 3800 lbs.

HAVE PATIENCE.—There has been an unusual pressure upon our columns, compelling the postponement of many articles of interest and value. Among these we may mention PROF. SWEET'S articles on Bad Habits in the Workshop, and Tools and their Uses ; MR. JOSHUA ROSE'S on Adjustable Screw Cutting Dies ; MR. BILGRAM'S on the Temperature of the Sun ; several of PROF. ROBINSON'S Centennial Reports ; DR. WAHL'S on Fuels ; MR. GRIMSHAW'S on Brick Machines, India Rubber, etc.,—and any number of illustrated descriptions of machinery of various kinds. These will all come in due time. Our Centennial Notes will be continued for some months yet ; and will be prepared with a care amply atoning for their slow appearance.

INVENTIONS WANTED.—If, instead of devoting so much time to the production of an infinity of car couplings and animal traps, and in ringing all the possible changes in bell-punches for car-conductors, inventors would look about them and endeavor to fill wants seriously felt, and the supply of which would be immediately and largely remunerative—the public would be greatly benefitted, and capitalists saved a terrible amount of *boring*. Referring to the demands made by callers and correspondents of this office, we may say that a good machine for digging potatoes would pay ; street-car motors are far from perfect, and steam plows and road locomotives, in this country, still further behind the requirements. There are no red or blue pencils worthy the name ; india-rubber cannot be *de*-vulcanized on a paying scale ; a power brake for freight-cars is needed ; a cheap system of fire-alarm telegraphy would pay ; Pittsburg and Wheeling call for smoke-consuming devices ; steam fire-engine builders would use injectors capable of working with wet steam ; portable gas-works supplying a fixed gas instead of a condensible vapor are loudly demanded ; fire-hose is too heavy ; there are few roofing materials that are light, tight, cheap, and sightly ; cities need some means of disposing of the snow which is banked up in their streets ; there is room for improvement in anti-friction bearings ; good and cheap household filters would sell well ; gas-meters are not what they ought to be, and water-meters will bear simplifying and cheapening ; artificial stone is not yet perfect ; steam-pumps, generally, are extravagant of fuel ; Delawareans would give any price for a machine to reduce by two-thirds the number of blossoms on their peach trees, in "overbearing years ;" the leading calender roll maker in the world says that there is not a really good emery wheel known to him ; type-setting and justifying machines are a great desideratum ; cast-iron gas and water pipe will some day be superseded ; belts do not convey enough power ; American bottles will not stand sufficient pressure to be used for champagne ; thousands of firms would buy good simple "type-writers" if they were rapid in action for short letters ; "printing telegraphs" for general use are unreliable and expensive ; there is no blue pigment that can be worked up in rubber goods ; no American manufacturer can make gum valves that will stand the action of hot or mineral oils ; no metal or alloy can compete with copper and tin for bell-metal.

There are too few band-saws used in mills ; ships' sails are not strong enough in proportion to their weight ; the problem of steam on the canals is not yet successfully solved ; there is no really fire-proof construction practised here ; horse-shoe machines are greatly wanted ; family fruit dryers would sell well ; safety matches are not sufficiently known ; and chromatic printing presses are very crude and unsatisfactory.

The foregoing list, taken "helter-skelter," might be increased ten-fold, by adding matters within our own cognizance, but concerning which no inquiry has recently reached this office.



HOOLE'S AMERICAN PERFORATOR.

(MACHINERY HALL, CENTENNIAL EXHIBITION.)

The above cut (Fig. 1) gives a fair representation of a new Perforator, which differs radically from anything hitherto offered to the trade, and should possess many advantages over those now in use.

The punctures made by the rotary cutter are oblong-square instead of round, and are made by a circular cutter running in the slot of a wheel placed in correspondence with it (see Fig. 2.) Any number of pairs of cutters can be used that the length of the two shafts will accommodate, and each pair may be adjusted to any required point. All perforators hitherto made have this objection—that when, as in check-books, it is desired to stop the perforation at a given point, the work is cut to that point, and the machine then worked backward, involving an expenditure of just twice the time which is really necessary.

The Rotary Perforator does away with this waste, its lower shaft being provided with a cam on each end, which, when adjusted so to work, will lift the upper shaft (carrying the circular cutters) at any desired point, and lower it again after the paper has passed any given distance through the machine without perforation. This feature enables the operator to feed this class of work without interruption, and ensures double the speed obtainable by the usual "back-action" process.

The machine should not get out of order, as the working points should be kept true by the tongue and groove formed by the cutting and slotted wheels, in addition to the guide flanges on each end of the shafts. When the circular cutters become dull, they can readily be filed up. The side-gauge and feed-roll enable the operator to keep the sheet in place, and to feed square. The receiving box (which is not shown in the cut) takes charge of the paper as on the ordinary ruling machine.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

The Hudson River Tunnel.—Work on this this tunnel, which was begun two years ago, and interrupted by litigation, is soon to be resumed. It is entirely a private enterprise, nothing being asked from the public but right-of-way. The cash capital on hand is $10,000,000, and it is estimated that about $5,000,000 more will be required for the completion of the work. The litigation arose from opposition on the part of the Morris & Essex Railroad Co. and the Jersey Shore Improvement Co. The suits have all been decided in favor of the Tunnel Co. Active operations will now be begun on the New Jersey side from the foot of Fifteenth Street. Thence the tunnel will run in a northeasterly direction, passing under the river and the Christopher Street Ferry Slip. The entrance on the New York side will be in the vicinity of Washington Square. From the New Jersey shore there will be a gradual descent of two feet in a hundred until a point 2,700 feet from New York is reached, when the tunnel will begin to ascend at the rate of one foot in every hundred. The tunnel will be about two miles in length and have a road bed of twenty-three feet, with two tracks, and the entire distance will be lit by gas. At no point will the tunnel be less than twenty-five feet below the surface of the river, and in many places it will be seventy feet below. It is proposed to employ 200 laborers, and to continue the work day and night. In this manner the enterprise will be completed in about two years. The tunnel will be used for passengers, but its main object is rapid transportation of freight to and from the railroad depots in Jersey City. [*Railway Gazette.*]

An Inter-Continental Tunnel.—A pamphlet called the "Inter-Continental Tunnel" has been published at Madrid, advocating the connection of Africa and Europe by a tunnel under the Straits of Gibraltar. It is suggested that the tunnel should start from a point between Tarifa and Algesiras on the Spanish coat, and come out between Ceuta and Tangiers on the African side. The submarine part of the tunnel would be only nine miles long, but with an incline of 1 in 100. The tunnels of approach would be nearly six miles long on each side. The maximum depth of the sea at this point is said to be 3,000 ft.; and as a "crust" of 300 feet is to be left between the bottom of the sea and the arch of the tunnel, the latter will have to be 3,300 feet below the level of the sea. The originators of the scheme are of opinion that the cost will not exceed £4,000,000 sterling. [*Van Nostrand's*, May, xv,

Krupp, the well-known iron master of Prussia, has lately patented an ingenious mode of manufacturing car wheels. A skelp is first formed of a long flat plate of iron, with a central rib above and corresponding groove beneath, and wide at each end. One end is secured to a rotating mandrel and is coiled on itself, forming the hub; the coiling being continued, the narrow portion of the skelp is wound on itself, forming the web; the coiling of the outer wider end forms the rim. The blank thus formed is placed in the furnace, heated to a welding heat, and welded under pressure into a homogeneous mass of the proper shape, forming the completed wheel. Apart from the facility of manufacture, the invention results in the production of an article of very superior merit, as the fibres of the iron are all arranged parallel to the periphery instead of being tangential or radial, as in wheels constructed by processes hitherto pursued. [*Railway Review*, xiii, 172.]

An Improved Knife Grinding Machine (made by the Northampton Emery Wheel Co., Leeds, Mass), has an emery wheel in the form of a hollow cylinder or shell, which, as it simply *grows shorter* by wear, does not grind more and more concave as it is worn away. By grinding with one edge, bevels are given a concavity varying with the amount of "skew" given the track; by grinding with both edges, and with the track in line, a flat bevel is given.

An "Improved" Car Brake has spring clutches to catch a squared portion of the axle. Has the inventor ever stopped a lathe or other light machine, accidentally or purposely in this manner?

An Improvement in Sleeping Cars (by J. Grant), is to prevent the closing of the upper berth in case of a turn over or wreck.

A New Station Indicator is being tried on the Fitchburg R. R. Before coming to each station, one of a series of hinged name tablets, 18 by 6 inches, is brought into view in each car; the device being operated by a cord.

Metallic Cars are made in considerable quantities in Providence, R. I., by the La Mothe Manufacturing Co. One weighing 5500 lbs. has a maximum load of 33 tons.

Egerton's Tidal Pier.—Some experiments were tried at Clapton, on Tuesday last, before a numerous company of engineers and others, to illustrate the working of a new tidal pier invented by Mr. H. A. Egerton. The extreme incline which the brow to an ordinary floating dummy assumes at high and low water in all rivers and estuaries where there is a large rise and fall of the tide, has prevented their being of much use except for the embarkation and disembarkation of passengers, and great trouble and delay are always experienced in the conveyance of goods in such cases, as they have to be unloaded at the head of the brow, carried down to the ferry boat, and loaded again on the other side. By a very simple and ingenious arrangement of a system of floating dummies carrying a causeway made in separate pieces, and regulated by means of a series of lazy-tongs, so as always to be retained at the same level, Mr. Egerton, it would seem, has at last given to the world what it so much needed, namely, a cheap and durable floating pier, which may be so constructed as to form at any state of the tide any incline which may be considered most desirable, and which is self-regulating, without any expensive hydraulic machinery, according to the state of the tide. As it would be impossible to describe the system without the help of drawings, we shall not attempt to do so now, but hope on a future occasion to give our readers a full and detailed account of it [*The Engineer*, xlii, 352.]

A New Car Axle, by E. J. Bowen, of Kent, Ohio, has a steel sleeve pitted to the journal, and secured by a screw or nut in the end, and also doweled to prevent turning. Grooves are cut in the axle with vent openings to induce cooling air currents inside the shell. [Abr. from *Nat. Car Builder*, vii, 183.]

The Empire Vacuum Brake, which has been in successful operation for a long time on the cars of the New York Elevated Railway, has often been mentioned as having many of the qualities suited to a freight-train brake. It is worked by an ejector on the engine, which exhausts the air from the center of an iron cylinder under each car, causing the external pressure to act upon two piston-heads, one in each end of the cylinder, and force them towards the center, the piston-rods acting upon the brake levers, and applying the brakes to both trucks. Whether the apparatus can be so adjusted or modified as to brake upon only one truck, we are unable to say, but we should think it might be, unless it should affect in some way the validity of the patent. In regard to the cost, the only estimate we have heard places the expense of the complete equipment at $45 per car, including royalty. This is too much by nearly one-half. The cost of a brake for this purpose, to be readily and widely adopted, should not exceed $25 per car.

Another device which seems to be regarded with a good deal of favor, is the

Eames Vacuum Brake, consisting of a simple iron cylinder, containing a flexible, movable head in connection with a piston, the stem of which is attached to the brake levers. The air is exhausted by an ejector. There is no complexity of valves and cocks, no packed pistons or release springs, or any parts requiring lubrication or special attention. The application and release are both instantaneous; it can be used as an automatic or plain brake, or both combined, on the same train, and with great economy of steam. The comparative cost of the plan as applied to passenger cars, is claimed to be about one-third that of the compressed air or Westinghouse system. It is claimed by its proprietors to be specially adapted to freight trains, on account of its small cost, simplicity and durability. As we understand its construction, it can be applied either to one truck or two, as may be desired. [*R. R. Gazette*, vii, 184.]

MINING, METALLURGY AND MINERALOGY.

The New Nomenclature.—Mr. Jacob Reese, of the well-known steel-manufacturing firm of Reese, Graff & Woods, of Pittsburgh, writes to the *Railway Age* of Chicago in deprecation of the recommendation of the International Committee of the American Institute of Mining Engineers to change the names of iron and steel products. He says:

"1. *Weld Iron* is recommended to cover the class now well known as wrought iron, and nothing more. There is no difficulty here, as all persons know that wrought iron welds, and I see no reason for changing the well-known words, wrought iron. The term *weld iron* is also objectionable because all grades of steels weld under certain conditions; indeed, the highest and best grades of tool steel must be welded before they are fit for market.

"2. I object to the term *weld steel*. The term should signify, if it means anything, that it covers all the class of steels which are capable of being welded. This is not so, as it is only intended to cover that class which has been welded from small particles not capable of being hardened; and as steel made by any process known to me may be welded under proper conditions, the term is not well chosen, and is calculated to mislead and muddle the matter much more than anything heretofore.

"3. *Ingot Iron.*—This term is also objectionable, as ingots not capable of being sensibly hardened by tempering are now made by the crucible process, the Siemen-Martin process and the Bessemer process, and, as is well-known to the trade, the product of each process possesses distinct characteristics, each being best adapted for certain uses. Therefore, ingot iron would be but a general, meaningless term, calculated to deceive and lead to error, and loss of life and property.

"4. *Ingot Steel.*—This term is also objectionable, because it is but a general term, signifying that it was cast while in a fluid state and will harden by tempering. Now the effect of carbon on iron, as exhibited in the phenomenon of temper, arises from the fact that the force of attraction is exerted by carbon in one hundred times greater degree than that force is exerted by iron; hence if the particles of iron are held together by this force so that it will require a tensile strain of 60,000 pounds to rupture one square inch of such iron, if one per cent. of carbon be added thereto the force of attraction is doubled, and the bar then will require a tensile strain of 120,000 pounds before it can be ruptured. From this it may be conceived that every particle of carbon incorporated in the iron will add proportionately to its aggregate attraction, and consequently iron, under proper treatment, absolutely tempers in degree with the amount of carbon it contains. I consider this term ingot steel as meaningless as far as the wants of the trade or the consumer are concerned. There are many processes by which ingot steel is made, and the qualities of each differ from the other, and the cost of manufacture differ; hence we should not class them all together. It would be great injustice and cause great distress to some branches of trade and lead the consumers into trouble. While I admit the necessity of a revision of the nomenclature of iron and steel, I think that, as the new processes which have caused the trouble are still unfolding new facts every day, the matter should be postponed for a few years."

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Coloring Process for Gems.—There is a factory in Idar, Germany, where the coloring of stones, for art purposes, is said to be carried on to a greater extent and more perfectly than in any other part of the world, the process pursued in thus converting chalcedonies and red and yellow cornelians into onyxes resulting in the production of admirable specimens, which are known and prized in all the markets of Europe and America. The peculiarity of this process consists in the fact that the ribbons or zones in the different varieties of chalcedony—which, in the kidney-formed masses of that substance, lie superimposed—differ in their texture and compactness; but owing to their similarity of color in the natural state, they can only be distinguished from each other with difficulty. The stone is, however, capable of absorbing fluids in the direction of the strata; and as the strata possess this property in different degrees, it necessarily follows that if a colored fluid be absorbed, and the quantity taken up by the pores of the stone, is different from every stratum of zone, a number of tints will be produced corresponding to the number of zones, each being distinct and colored in proportion to the quantity of the fluid absorbed. In this way a specimen of stone naturally but slightly colored, may be rendered equal to fine stratified chalcedony or onyx, and may be employed equally well in the engraving of cameos, or for any other purpose where the variety of color can be rendered available. [*Am. Art Jour.*, ii, 5.]

Etching Action Produced upon Different Metals by the Acids.—The following is an abstract of a paper presented to the French Academy, by MM. Tréve and Durassier:

"It is known that the action of acids upon metals gives rise to various figures which have been sometimes considered as calculated to throw a light upon the internal structure of the metal. We have had occasion to make certain observations, which seem to show that in the conditions in which we operated the figures are connected, not with the internal structure, but with the external action exerted by the bubbles of gases disengaged during the reaction of the acids. The authors give an illustration representing two horse-shoe magnets which have been plunged into acids, and which are grooved in a regular design, not capable of being made intelligible by a mere description."

Carbonic Acid as a Motor.—Herr Beins, of Gronnigen (Holland), is of the opinion that carbonic acid (which he terms Carboleum) will be the long-looked-for successor of steam, as a motive power. He has shown that, when sodium bi-carbonate is heated in a confined space, a portion of its carbonic acid is liberated, under any degree of tension; so that, for example, by heating the bi-carbonate to about 200 or 300° (about 400 to 575° Fahr.), liquid carbonic acid is obtained under a pressure of from 50 to 60 atmospheres (750 to 900 pounds). If a more moderate pressure is wished, it is only necessary to moderate the amount of heat applied, so that it is quite within the power of the operator to store up the acid at any desired pressure. The observations of Herr Beins are practical enough to warrant the attention of those are interested in the matters he discusses. He certainly indicates a cheap and practical method of generating a prodigious amount of energy, the utilization of which is attended with even less difficulties than steam.

Cobalt Plating.—From the analogy in chemical properties, existing between the metals nickel and cobalt, it is *a priori* probable, that by employing in the battery the cobalt compounds corresponding in chemical constitution to those successfully employed in the process of nickel-plating, a similar deposition of cobalt should be obtained. This statement is confirmed by the *Jahresbericht d.phys. Vereines in Frankfurt*, where it is affirmed, the most beautiful cobalt plating may be obtained upon brass and copper, by employing in the battery (with two Bunsen cells), a moderately concentrated solution of the double chloride of ammonium and cobalt. This solution is prepared by dissolving 40 grammes of crystallized chloride of cobalt, and 20 grammes of chloride of ammonium, in 100 cub. centim. of water, with the addition of 20 cub. centim. of ammonia. The cobalt deposit takes place rapidly, and attains in a short time such a thickness that a magnetic needle is decidedly affected by it.

Electric Light.—An ingenious new arrangement for the electric light, in which all the ordinary mechanism for securing the proper approach of the carbon points to each other is dispensed with, has been devised by M. Labloschkoff, in the works of M. Denayrouze. The two carbons are fixed parallel at a small distance from each other, and are separated by an insulating substance which disappears along with them. When the current passes the voltaic arc is formed at the free extremities of the carbons. The layer of insulating matter immediately below gets fused, and is volatilized or flows slowly down, just like wax down a candle, as its combustion progresses. The heat of combustion of the carbon, lost in the air in the usual system, is here utilised to melt and volatilize the insulating mixture. The latter may be made of various substances (sand, glass, mortar, lac, etc.). A mixture of sand and pounded glass does very well, and is cheap. The light arising from incandescence of this substance in the voltaic arc gives effects like those of the Drummond light. [*Eng. Mech.*, xxiv, 239.]

Use of Petroleum to facilitate Metal-Working.—The application of petroleum as greasing material in turning on the lathe very hard metals is of great advantage, since cutting-tools continually wetted with petroleum, may easily attack and work the hardest sorts of steel, which it would be almost impossible to work without the application of this means. It has been shown that a very hard alloy of 7 parts of zinc, 4 parts of copper, and one part of tin, which even with the best hardened chisel could not be worked, could be turned with the greatest ease on a lathe, if the tool is moistened with petroleum. With the now more and more frequent use of steel, this discouery is of no mean importance. [*Stummer's Ingenieur*, Sept. 1876.]

The Extraction of Iodine and Bromine.—A new process for extracting the iodine and bromine contained in wrack and other marine plants, in their fresh state, is recommehded by E. P. Alexander in the "Technologiste." He dispenses with all preliminary processes, chemical or mechanical, and, amongst others, with burning them, simply submitting the wrack, etc., to the action of lime-water of a fixed strength and quality. The iodine contained in those plants passes into the lime-water, which, thus charged with iodine, is evaporated to dryness by the usual means, after having been treated with a solution of carbonate of potassium, changing all the iodine and bromine into salts of potassium. After evaporation, the mass is calcined to expel organic matter. [*Pract. Mag.*, vi, 344.]

Homœopathic Treatment of Boiler Scale.—Mr. Rowan suggests in a paper before the British Assoc'n that a thin artificial scale of calcium sulphate and magnesium hydrate will prevent corrosion of the plates.

A New Blow-Pipe, designed for heating large objects, has a closed chamber filled with burning charcoal or coke, and having a blast pipe at one end and one or more flame nozzles at the other.

NOPALINE.—Mr. Max Singer, of Tournai (says the *Moniteur Industriel Belge*), speaks of this new and remarkable chemical product substantially as follows: It produces a brilliant red, more beautiful than the scarlets and "ponceaus" given by cochineal. Recently it had been hoped to produce reds either by eosine or by a mixtuie of safranine and aniline yellow; but practical men have learned that these dyes do not give the desired resnlts; the cost has been too high and the color not sufficiently permanent. In a word, cochineal has not been replaced. The new product, "nopaline," does this last; giving reds that are bright, do not wash out, are cheap, and need no mordant; and the wool is not stiffened by the scarlet composition nor by oxalic acid. The price is 60*fr.* per kilogram (2·2 pounds).

Similar tints are produced on spun wool, by either of the following compositions—the quantities and cost being for one kilo. of wool:

15 grammes of nopaline, costing 96 centimes, and 50 grammes of alum, costing 5 centimes—in all 101 centimes; or, 120 grammes of Zacatilla cochineal, costing 93 centimes, 50 grammes of oxalic acid, and 25 grammes of tin salt, costing 5 centimes; in all 98 centimes.

Nopaline reds are brighter, the wool softer, and the dye can be guaranteed to stand washing and frilling, without becoming tarnished or turning violet. This will be appreciated by those who know the annoyance which cochineal causes.

A New Alloy—"Sideraphthite"—by Schmitte, resists sulphuretted hydrogen; is not attacked by vegetable acids, and mineral acids have but a feeble action thereon.

It is compound of iron, 65, nickel 23, tungsten 4, aluminium 5, copper 5. This new metal, or inoxydizable iron, can replace those metals or alloys which it is necessary to protect with silver-plating. [From *Mon. Ind. Belge.*, iii, 522.]

Hygienic Influence of Compressed Air.—It has been supposed by some that the effects of compressed air on workmen were injurious. But Siebe, an eminent German hydraulic engineer, has established, by a series of experiments during several years, the fact that workmen working in caissons, attain, in a short time, a remarkable degree of comfort; and that their chests become strengthened to a remarkable degree. He has also ascertained that pulmonary complaints become cured by thus working under water. In consequence of this, Dr. Carlo Farlanni, of Milan, has established an aërotherapic establishment, for the treatment of pulmonary complalnts. [*Revue Industrielle*, Nov. 22,]

[The aërotherapic treatment was noticed in our journal some months since.—EDS.]

Varnishing Looking-Glass.—Varnishes are not well suited for casting mercurial looking-glasses; they seem to penetrate the film and dull the coating Nothing seems to work better than a thin coating of plaster of Paris, made very thin, and strengthened with a little gum water to give hardness. This effectually protects the "silvering," and renders it even whiter and more reflective than before. [*Exch.*]

MISCELLANEOUS.

The Cattle Plague.—M. Amédee Philiber, a Russian grazier on an extensive scale, affirms that above all the means used to preserve horned cattle from the cattle plague, the best is the distribution of sea-water, instead of sweet water, to the animals during the epidemic. [*Rivista Scientifico Industriale*, August, 1876.]

—Mr. J. Newton, C. E., has suggested that if another Arctic Expedition is despatched, the mechanical engineer should be called to follow up the path where "Jack" properly stops, viz., as far as his ship can go. The nucleus of the suggestion rests in the discovery by Mr. Hart, naturalist to the late Nares Expedition, of a seam of coal, whereat it is proposed to establish a colliery for the supply of fuel to suitably built locomotives, which should be provided with or capable of driving ice-cutting apparatus, as well as being able to pull one or more huts or carriages provided with every requisite.

Cheap Washing.—A new system of washing has lately been introduced in some French towns, which system deserves to be especially mentioned, The economy which it affords is so considerable that its cost is reduced to the following figures:—5 centimes (½*d.*) for a pair of drawers, 2½ centimes (¼*d.*) for each shirt, and so on.

This is the process: One kilo (2lb) of soap is reduced with a little water to a sort of pap, which having been slightly warmed, is cooled in forty-five litres (10 gallons) of water, to which is added one spoonful of turpentine oil and two spoonfuls of ammonia; then the mixture is agitated. The water is kept at a temperature which may be borne by the hand. In this solution are introduced the white clothes, and they are left there two hours before washing them in soap, taking care in the meanwhile to cover the tub. The soapy water may be warmed again and be used once more, but it will be necessary to add half a spoonful of turpentine and another spoonful of ammonia. Once washed in soap, the clothes are put in warm water and the blue is applied. This process, it is obvious, spares much time, much labor and fuel. On the other hand, it gives to the clothes a whiteness much superior to that obtained by any other method, and the destructive use of the beetle is not necessary to clean the clothes from the impurities which they contain. [*Gaceta Industrial*, Sept. 25th, 1876.]

Spontaneous Combustion of Oily Refuse.—J. J. Coleman, of Glasgow, recently transmitted to the Société Industrielle of Mulhouse, France, a memoir on the spontaneous combustion of oily refuse and on the relative inflammability of the different oils employed for lubricating purposes. He describes a series of experiments upon fragments of cotton, linen, jute and woolen waste, saturated with oils of different natures. The materials were placed in a box of tin, having a double bottom in which steam entered, so that the part which received the refuse could be maintained at a temperature of 180 degrees Fahrenheit. A thermometer was inserted in the oily substance, so that the variations of temperature occurring therein could be noted.

The results obtained show, first, that any vegetable or animal oil inevitably takes fire after a few hours, under the above conditions. On employing cotton waste, the mass burns quickly and with flame, in contact with the air. Wool refuse is slowly transformed into a black carbonaceous mass. Second, the addition of mineral oil—known as lubricating mineral oil—serves to retard the spontaneous combustion of vegetable or animal oil if mixed in small quantity. If a large amount be added, inflammation is entirely prevented. The mineral oil used by Mr. Coleman is a very dense product (density 890), having great viscosity and emitting no inflammable vapors even in contact with an ignited body at any point below 338 degrees Fahrenheit, or, in other words, remaining safe at temperatures at which mixtures of less dense mineral oils or colza oil burn. The addition of forty per cent. of mineral oil is sufficient to prevent spontaneous combustion. Twenty per cent. doubles the time necessary to determine conditions favorable to the same. Spontaneous combustion occurs most quickly when the cotton is soaked with its own weight of oil.

The Messrs. Dolfus, who presented Mr. Coleman's paper to the above named society, add the results of further investigations of their own. They note the fact that access of air is indispensable to the obtaining of a sufficient elevation of temperature to determine combustion, and that it was found necessary even to blow air into the hot box.

There is another advantage to be gained by mixing mineral oil with that of vegetable origin, in that the latter is thereby prevented from resinifying, or thickening, on prelonged exposure to the air. Mr. Coleman exposed in hot air bath, for a period of forty-eight hours, vessels containing olive, colza, sesame, and cotton seed oils. The first thickened, the second the same to a greater degree, the third more, and the last yielded a semi-liquid, amber-colored mass. The addition of twenty per cent. of mineral oil caused all to remain perfectly fluid. The author concludes that, for the lubricating of machinery, as well as for the oiling of textile fibres, it is advantageous to employ a mixture containing as much mineral oil as is possible while retaining the material at the proper degrees of viscosity. Colza and other oils employed for lubricating heavy machinery are greatly improved by the addition of from ten to twenty per cent, of mineral oil, the small viscosity of the former preventing a mixture of greater proportions of the latter. For spindles, on the contrary, it is better to use a larger amount of mineral oil, making a mixture of about the viscosity of sperm oil.

Wood Hangings, so favorably adopted as a substitute for wall paper in buildings, have recently been used in passenger cars.

American Beef is now shipped, in large and increasing quantities, to Liverpool.

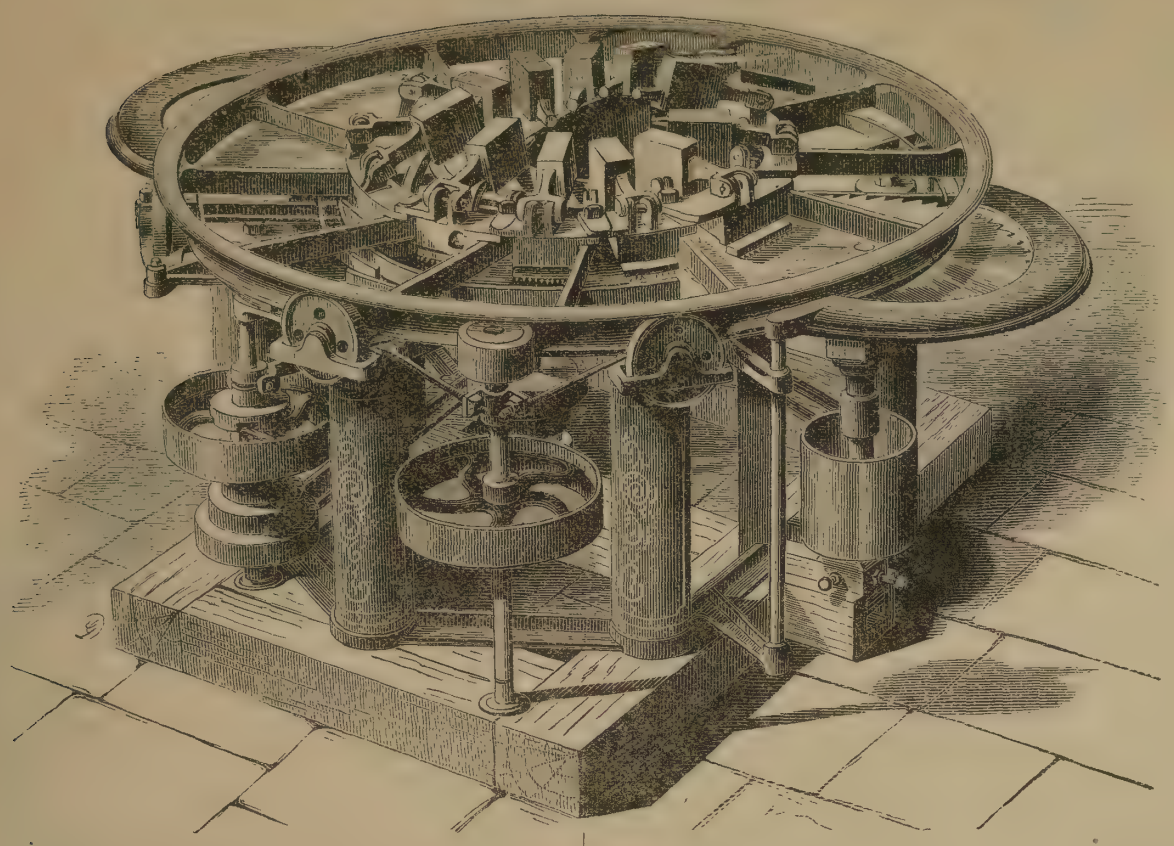
The New South Wales Exhibition of 1877 will be held at Sydney in April and May next. Hon. Mr. Morris (Executive Commissioner at the Centennial) suggests that manufacturers of agricultural and timber-felling machinery should find in Australia the best of markets.

An Improved Poison-Bottle, of coffin-shape, is comical enough to think of; but we can highly recommed the *enforced* use of certain and unmistakable shapes for poison vials.

The St. Gothard Tunnel was advanced, during the week preceding Nov. 20, 15·7 meters from the Gœschenen side, and 29·2 meters from the Airolo side; in all, 44·9 meters, or 6·4 meters per day. There was an interruption of 3½ days on the Gœschenen side.

(From the head of the tunnel at Gœschenen to that at Airolo, is 14,920 meters.) [*Mon. Ind. Belge*, iii, 522.]

CENTENNIAL NOTES.



Burt's 12-Block Rotary Shingle Machine

(Shown herewith) has an iron frame carrying two horizontal circular saws at opposite sides of the iron frame, above which, mounted on rollers and revolving above the saws, is a circular carriage divided by radial ribs or arms into 12 sectors of varying widths. At the inner end of each sector is a dog which advances and retreats in the horizontal plane twice in each revolution; this being effected by belt crank levers and inclined planes. A block being placed in a sector at a point midway between the saws, the dog holds it; and the table, revolving, carries the block to the saw, which cuts a shingle off the bottom; the dog then loosens the block and allows it to drop, again gripping it just in readiness for the next saw. The 12 sectors may all be filled at once, two shingles from each being cut at each revolution (or 24 in all.)

The shingles may have any desired taper, and may be either 16 or 18 inches long. The capacity of the machine is stated at 200,000 white pine or cypress shingles per day, 30 horse power driving the machine, drag saw, jointer, bolter, &c. Weight 5,000 lbs. Price $1250. Made by C. S. & S. Burt, Dunleith, Illinois; shown in Machinery Hall, B 54.

G.

C. ADAMS-COLLING

The Philadelphia Disintegrating Bone Mill.

Made by Kreider, Campbell & Co., 1030 Germantown Avenue, Philadelphia, and shown in Machinery Hall, E–50 and 51, corresponds, in principle of working, to the excellent mill so well known in England as Carr's Disintegrator.

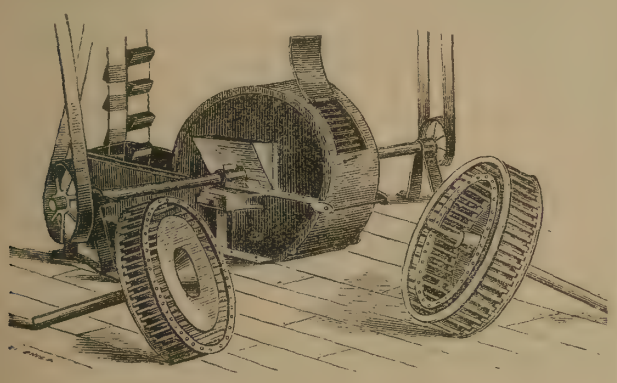


Fig. 1.—Disintegrator.

The back central figure, in the above cut, represents one of these mills set up ready for running. It is composed of a cast-iron case, two cast-iron disks, two wrought-iron shafts, and four cylindrical cages. The two shafts with their respective disks mounted are seen separate in front, on the right and left. The shafts are each four or five feet long. They run in a line, end to end, and have a peculiar conical central bearing, which secures the advantages of a through shaft, steady motion, and little friction and heating. The cages are of such different diameters as to work in line, one inside the other; and when set up they cover the central bearing.

The mill is fed from the centre; the cages revolve in opposite directions, and pulverize by percussion, while the material is passing among the cage bars and through from the inner to the outer side of the cages, whence it falls into a screen or elevator, as arranged by the user. The power depends, of course, upon the force and rapidity of the blows given by the revolving cage-bars, and is dependent upon their number of revolutions. They can be constructed double; the length, size, shape and closeness of the cage-bars, and the speed in running, are varied to suit the different materials or the character of the work to be done. It answers admirably as a coffee-huller.

The "Giant Breaker," made by the same firm and also exhibited, is seen in Fig. 2, and is well devised for heavy crushing.

G.

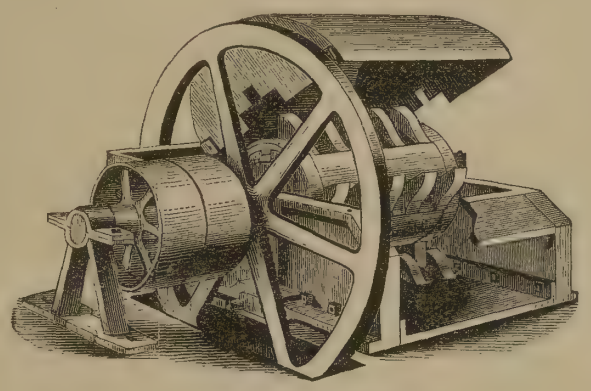
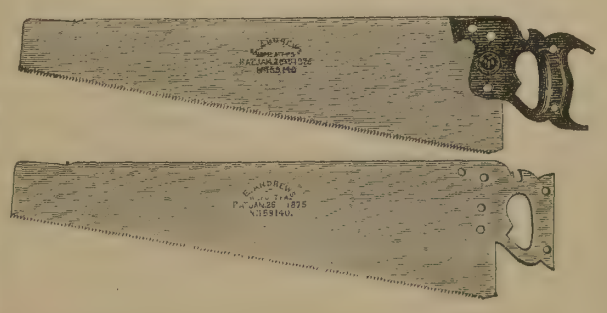


Fig. 2.—"Giant" Breaker.



An Improved Plan for Securing Saw Handles,

Shown by E. Andrews, Williamsport, Pa., seems worthy of commendation. By extending the saw-blade through the handle to that part held by the hand, the handle is strengthened against breakage; while more of the blade is clamped by the handle, and the two extra screws give additional firmness. As will be seen, the symmetry of the handle is not marred by this arrangement.

G.

Stillwell & Bierce's Feed Water Heater.

Stillwell & Bierce, of Dayton, Ohio, exhibited an excellent feed water heater and purifier, so clearly shown in the accompanying cut as to require no explanation. The adoption of these, or similar feed-heaters, should very soon produce a lessening of coal bills.

G.

Hoop Machines.

(Made by Roswell Hart, Rochester, N. Y.)

There is a device for riving poles of various sizesand forming the parts into perfect hoops. The pole is entered butt foremost between two vertical guide rolls; then between two pairs of horizontal rolls with a U shaped guide between. It is then presented to the edge of a vertical knife which has a vibrating motion, serving to *split* the pole while cutting at the same time. A vertical wedge against which the cloven parts come serves to separate them still further, aiding the splitting action of the vibrating knife, and separating the halves. Two anti-friction rolls at the base angles of the wedge ease the onward and outward passage of the rived halves of the pole. Under the horizontal feed rolls there is an elliptical spring accommodating them to varying sizes of poles; there is no adjustment to the first, or vertical rolls.

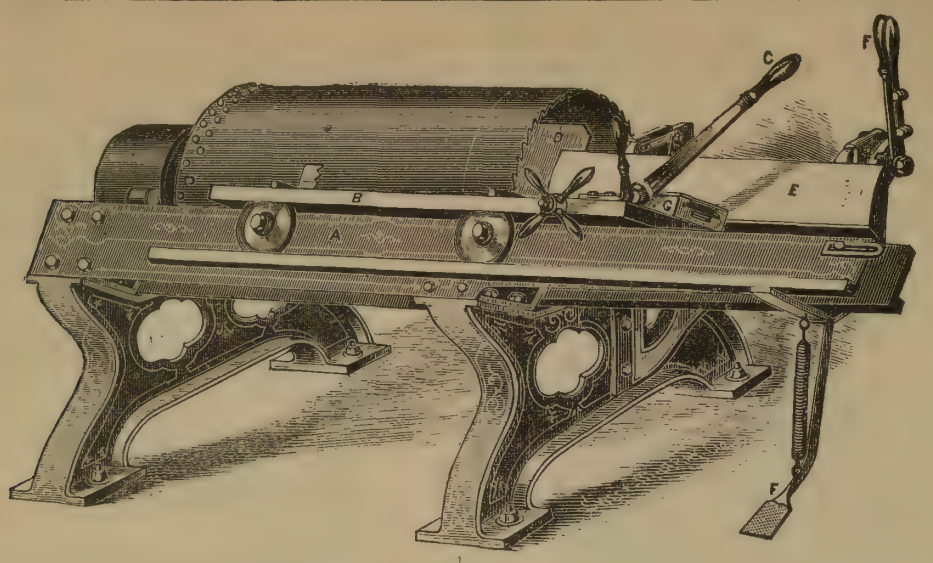
Should it be desired to use poles too large for halving, a three-part knife is brought down instead of the halving knife. There is then no vibration of the knife: but three rolls at angles of 120° part and carry away the thirds.

The rough splits are then ready for facing or finishing in another machine. This feeds the rived parts with their faces under and against a rapidly revolving cutter, which dresses them true and smooth. Any knot on the bark side is partly removed prior to this facing operation, by an automatic cutter head which removes the inequality at once.

The rapidity of speed of the machines is surprising. The splitter feeds at the rate of 9 ten-foot poles per minute; the finisher takes in 10 of the rough hoops in the same time. The splitter takes from 3 H.P. to 4 H.P., and turns out from 1000 to 1500 rough hoops per hour. The finisher or facer, requiring 5 H.P., has a capacity of 6000 ten-foot hoops per diem.

As regards the quality of the product, there is nothing to be desired; a slight superiority over hand-made hoops being observable. Each machine requires one attendant, unskilled labor sufficing. The splitter occupies a ground space of 2 by 5 feet, and weighs 800 lbs. The finisher takes up a space 8 by 2 feet, and weighs 1000 lbs.

G.



"CHAMPION" STAVE SAWING MACHINE.

[Peter Gerlach & Co., Cleveland, O.]

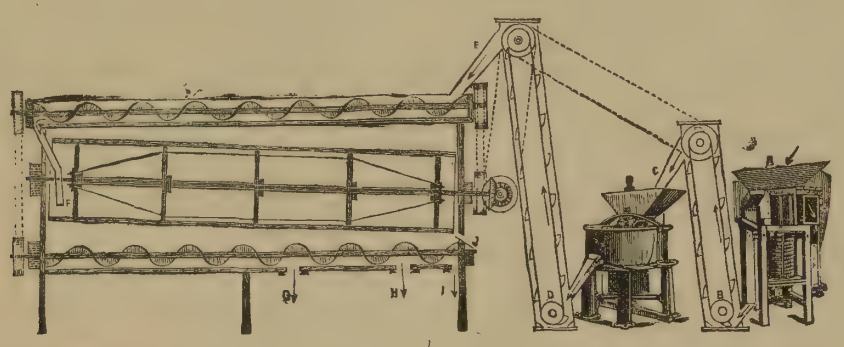
The above cut represents the oil barrel stave size as exhibited. The frame is constructed entirely of iron; the carriage-bed (A) and carriage (B) are arranged in an inclined position. This allows the stave bolt, when placed on the carriage, to slide to the gauge (without effort on the part of the operator). The carriage is provided with a dog (C), which holds the bolt firmly in position while the stave is being cut. This dog is constructed so as to admit of bolts varying 6″ in length, being cut without equalizing.

The carriage is fed by hand, thus giving the operator full control of the machine, and enabling him to regulate the feed according to the quality of timber and without danger of injuring the saw. When a stave is cut it drops into the trough (D), inside the saw, whence it is brought out by the backward motion of the carriage.

The lever (F), will allow the gauge to be thrown back so that the thickness of from two to five staves may be taken off at one cut if desired, and by pressing the foot on the treadle (F), it will be brought back to its former position and again cut the next stave of a uniform thickness as before. It may likewise be brought forward enough to hollow out the bolt before the first stave is cut, thus saving time and timber.

The cylinder saw is 24″ diameter, by 45″ long; is made from the best quality of iron with tempered steel face of 8½ inches; is "patent ground" on out and inside, trued and balanced by an improved process. This admits of a 24″ saw being run 1400 revolutions without the whipping and pounding incident to saws not properly trued and balanced.

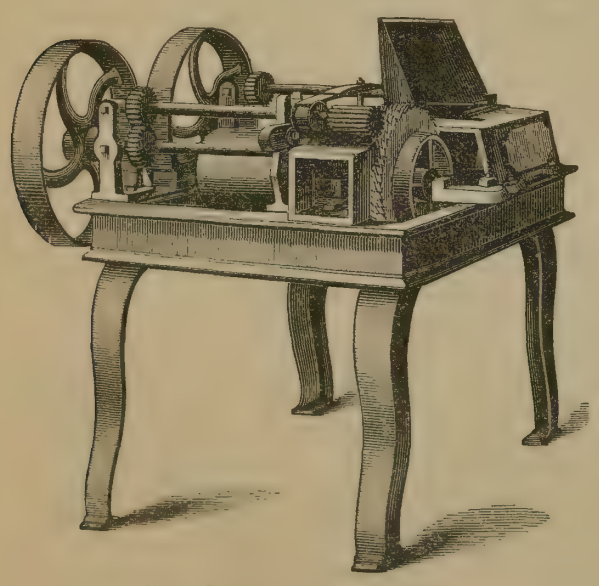
The makers state that at 1200 revolutions the best results have been attained; and that it will cut from 6000 to 8000 good staves in 10 hours—much depending on the power, quality of timber used, and ability of the operator.



FLOURING MACHINERY AND MILL COMPLETE.

(Leonard & Silliman, Bridgeport, Conn.)

The cut represents a French burr stone grist mill, with a full set of flouring machinery, ready to connect the driving power. The grain will enter the smut machine at A; is discharged to the elevator at B, and deposited in the mill hopper at C. The grist is discharged to elevator at D, and deposited in the cooler at E, which delivers it to the bolt at F. The first quality of flour is discharged at opening G, the second quality at H, the middlings at I, and the bran at J.



GANG LATH AND SLAT MACHINE.

("American Pattern.")

The cut represents a Gang Lath and Slat Machine, which consists of a hollow cylinder in which rings are fitted exactly the thickness of the lath or slats. The saws, which are six in number and 14 inches in diameter, have holes the size of the cylinder, and are placed upon the cylinder between these rings, which are then clamped finally together, so as to hold the saws in their places, rendering variation of thickness impossible. The cylinder is formed with arms inside, on the principle of a screw propeller, so that the motion of the cylinder forces through a strong current of air between the saws and arbor, preventing any heat from the journals reaching the saws; the greater the speed the stronger the current, and the cooler the saws keep. This kind of collar and saw may be used in all single saws as well as gangs. The machine is provided with spring guides, so that the operator can at will saw any number of lath at a time—from one to five—without changing anything about the mill. It has also four steel-clad feed rollers, two above and two below, all adjustable, and hung in oscillating boxes, so that it feeds itself; and the rapidity of the production of lath by it is only limited by the ability of the feeder and the width of the lath.

The makers claim that the uniformity in thickness of lath and slats produced by it is wholly unattainable by ordinary lath mills; that the product brings 30 per cent. more in market, while manufactured 40 per cent. cheaper than ordinary lath; and that the difference in 20,000 of lath per day will pay for one of the machines every 20 days.

The machines are wholly of iron and steel, frame included, and with cut-gearing.

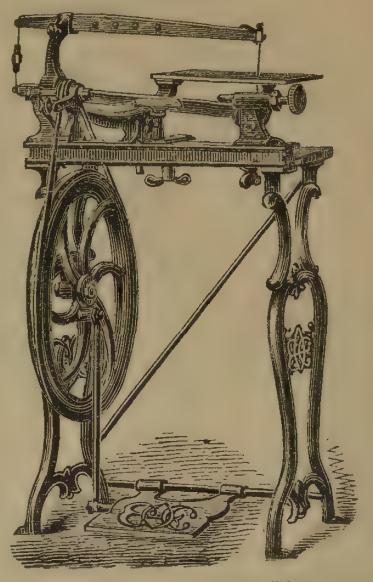
TheGang Lath Machine is warranted to cut 6,000 lath per hour, without heating the saws,

The manufacturers are Harvey, Easton & Co., Lock Haven, Pa.

THE "PANTECT."

[Made by E. O. Chase, Newark, N. J.]

The "Pantect" combination consists of an amateur wood turning lathe with twenty-inch fly-wheel, weighing 30 lbs.; grooved pulleys and patent "V" belt; iron bed planed smooth, and accurately fitted head-and-tail stock. The end of the conical bearing head-stock spindle is provided with a screw, to which are fitted all the face plates, chucks and fittings used in working, while the rear or outside end is bored and made to serve as a drill-chuck, carrying small drills for boring the wood holes necessary in entering the scroll-saws for inside work.

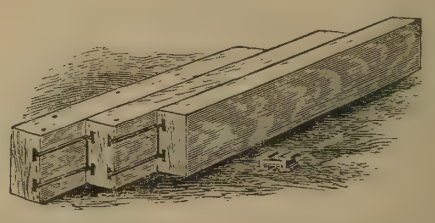


On the black walnut tool table or shelf at the back of the lathe bed, stands the scroll-and circular-saw frame, held in place and clamped to the table by a thumb-bolt, on which it swings—either forward, to connect the scroll or circular saw to the running spindle, or back, to be out of the way of the lathe when turning or polishing is to be done.

This saw frame consists of a standard casting, in which are bored the fulcrums of the vibrating levers of the scroll-saw, and hinged to which is a light iron saw-table and sweep, which, when in position for sawing, connects the frame and table with the lathe-head, and brings the connecting running parts into their proper position. The lower saw-arm is given its reciprocal motion by a face plate connecting with the lathe spindle—this face plate having a hardened wrist-pin, which carries a composition box running in steel slides on the saw-arm.

The scroll-saw-arms are also provided with a quick adjustment for different lengths of saws, a cam for throwing the tension on or off, and clamps for holding either fine or coarse saws.

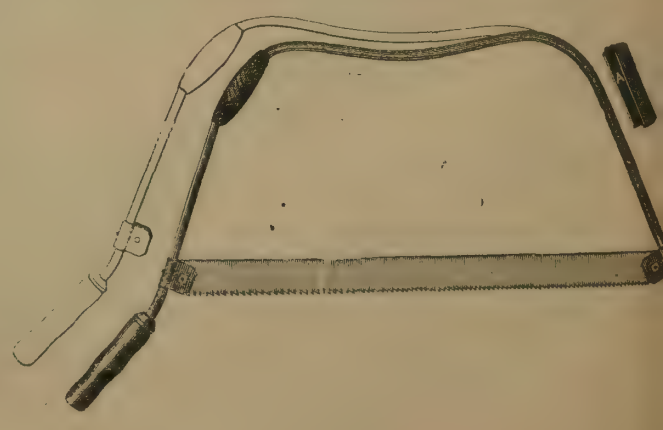
When the circular saw is to be used, the face-plate is thrown off and drops out of the way, allowing the cross-cut or rip-saw to be placed directly on the end of the lathe spindle, where it is held by an outer washer nut, which also serves as the spur centre of the lathe, and passes through the iron table to a sufficient height to saw work an inch and one quarter in thickness. The table is also provided with stripping, square and miter guides, and is adjustable for rebating, grooving, etc.



The cut shows a very strong slide for extension tables, made by Hammacher & Co., N. Y. Being in H form, it gives a maximum amount of rigidity and strength.

A SELF-STRAINING SAW FRAME,

Made by E. Andrews, Williamsport, Pa., and shown herewith, is made of oil-tempered spring steel; is light and strong, and should bear out the maker's guarantee that it will not warp nor lose its elasticity, nor be affected by any changes in weather. As will be seen, it has the advantage of being without the troublesome straining device, and can take in a stick of unusual size.—Commended. G.



THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. II. PHILADELPHIA, DECEMBER 16, 1876. NO. 24.

CALORIC ENGINE AND SIREN.*

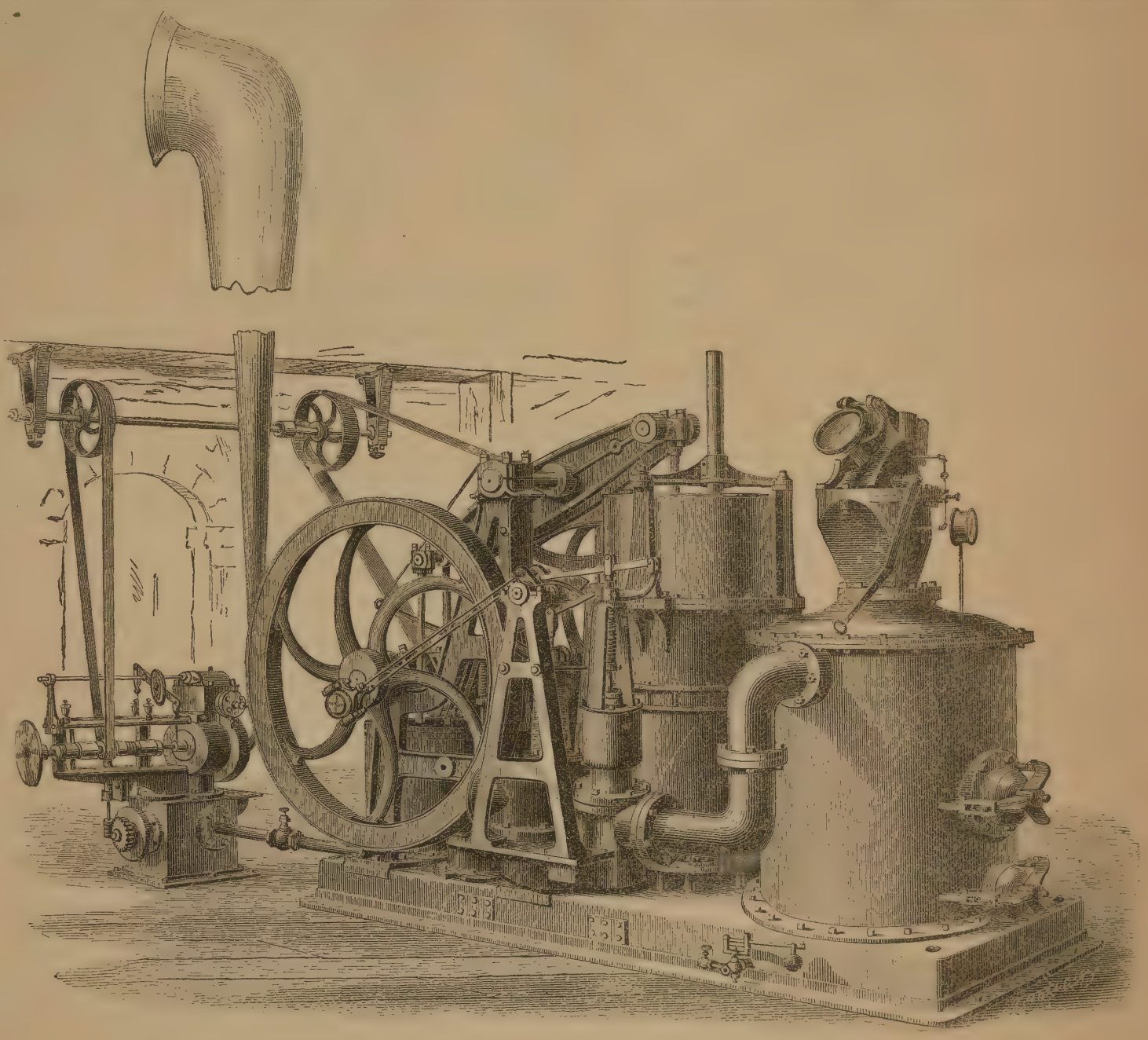
[Fog Signal Building, Centennial Exhibition.]

The engine has a cylindrical furnace (seen at the right of the engraving) measuring internally about 24″×24″. The feed is fed in from above through a hopper having air-tight valves at top and bottom; the bottom valve being kept closed and the top valve open (as seen in the cut)—except when feeding, when the hopper being filled, the top valve is closed and the bottom one opened to allow the feed to fall into the furnace—after which the bottom valve is closed again.

The air necessary for combustion is fed in by a pump at a pressure of 15 to 25 lbs. per square inch. To permit of lighting the fire there are two handholes, with suitable caps fitted with square center projections, to facilitate re-grinding in position. The air is fed in so as to strike these handholes and caps and keep them comparatively cool. The main piston is a plunger 32″ diameter, 20″ stroke. The lower section of its cylinder is enlarged in bores so as to give about half an inch circumferential clearance to the piston below the upper or bored 15 inches; and is also thinner than the upper, to aid in keeping it cool.

The plunger is packed by a leather ring, on the upper and cooler portion of the cylinder, and oiled from outside the cylinder. The air-pump piston is 22″ diameter, 22″ stroke; is leather-packed and oil-lubricated; it and the plunger are suitably connected with the walking beam; the fly-wheel is 8 ft. in diameter, and 2400 lbs. in weight. The crank-shaft is steel; 6 ft. long and 4⅛″ diameter.

The air-pump is single-acting, with quiet poppet valves. The working plunger has a round guide-rod 3″ diameter, passing through a guide-piece bolted to two uprights on the main cylinder.



BROWN'S CALORIC ENGINE AND SIREN.

The gaseous products pass from the combustion chamber through the curved-pipe shown, which is of cast-steel and 6″ in diameter, and which is connected with the casing of the vertical induction valve shown. To this casing is bolted the valve-stem-guide, bearing a projecting arm. To this arm is pivoted a lever which passes through an eye in the induction valve-stem, and extends over a wiper or toe, actuated by the eccentric and rods shown on the outside of the crank-shaft. The cut does not show a recent addition—an adjustable cut-off. As now made the engine has a lever pivoted to the top of the valve-stem (about an inch above the lever first described). This top lever has near its pivoted center a cam projection; and the lower lever, which rises and falls in the eye of the valve-stem cannot lift this stem until it strikes the cam on the upper lever. A screw and crank handle adjust this cam, and through it, the point of cut-off. The induction-valve is closed sharply by the spiral spring shown upon its stem. An eccentric on the main-shaft operates the exhaust-valve by means of a wiper. There is attached to the induction-valve a governor of the ordinary type.

The engine covers a floor space 11 by 6 ft.; weighs 6 tons, and is well built and fitted.

The siren shown at the left of the engraving is driven by belts from the engine just described, and "blown" with air from its pump. The rapid rotation of a metallic disk, pierced with holes at equal distances in a series of concentric circles, before another, but stationary disk, similarly pierced, affords a means of intermitting the air blast at any desired rate; more rapid rotation producing more frequent intermittance, and consequently higher "pitch" of tone; while the "intensity" or loudness of the sound depends upon the volume and pressure of air admitted, and the size and shape of the metallic horn (only parts of which are shown) which reënforce the vibrations.

The song of this siren (*lucus a non lucendo!*) is warning and far reaching. The extremely disagreeable roar which so distracted all within a long radius at the Centennial Exhibition might be so modulated (by a change in form, size, and material of the trumpet) as to be less harsh and distracting to landsmen's ears; but be that as it may, its strong and warning note of danger is to the mariner the sweetest music. G.

*Manufactured by A. & F. BROWN, 57 Lewis Street, New York City.

HOT PRESSED *vs.* COLD PUNCHED NUTS.

We are now ready to receive suggestions relative to our proposed series of nut-tests. We cannot and will not promise to adopt all or any of these suggestions; but they will be valuable as indicating the points which it is especially desirable to bring out by experiment; and as far as we can in fairness follow them out, we shall do so. When the plan for testing is fully elaborated and determined upon, it will be duly announced in these columns, in order that materials for the tests may be sent. It is needless to remark that these tests will be as accurate and as impartial as it is possible to make them. They will be properly certified and elaborated, and while we agree with our Pittsburg correspondent* that it is much more important to establish a proper series of proportions and sizes, than to test the strength of nuts, any one of which is strong enough to strip a steel bolt, we think that a careful series of tests would aid in showing just how far a reduction in sizes would be safe, where a change in proportion is desirable, and practicable. G.

* See this journal, Nov. 11, p. 151.

J. B. HOYT'S FURNACE FOR THE COMBUSTION OF BITUMINOUS COAL WITHOUT SMOKE.

In the Boiler House, attached to the Shoe and Leather Building, at the International Exhibition, was placed a plain cylindrical, tubular boiler, from Messrs. J. C. Bowser & Co., of Fort Wayne, Indiana, and in connection therewith the furnace above-mentioned.

Among the many efforts of latey ears to so perfectly consume the gaseous matters which constitute so considerable a part of bituminous coals, as to prevent the formation of the dense black smoke which usually attends their use, as well as to achieve the superior economy which must accompany their perfect combustion, this furnace appears to have met with a most decided success, and will therefore be of much interest to the engineering community. From experiments had with it, which have been complete and quite extended, its capacity to consume without smoke the bituminous or semi-bituminous coals seems to be very certainly established.

The complete combustion of these varieties of coal fails ordinarily from several causes. The prerequisites to this operation being carried on in a manner practically perfect are : 1st, that sufficient air shall be admitted through the grate upon which the fuel rests, to supply the oxygen necessary to the complete combustion of that part of the coal which maintains the form of solid carbon, and no more; 2d, to admit sufficient air above the surface of the bed of coal to supply the oxygen necessary to combine with the combustible gases distilled from the coal upon its contact with the hot coals of the previous fire, and no more; 3d, to supply this latter at a temperature sufficiently high to make the combination of its oxygen with these gases possible; and, 4th, to provide for making the distilled gases themselves sufficiently hot to combine with the oxygen of the heated air.

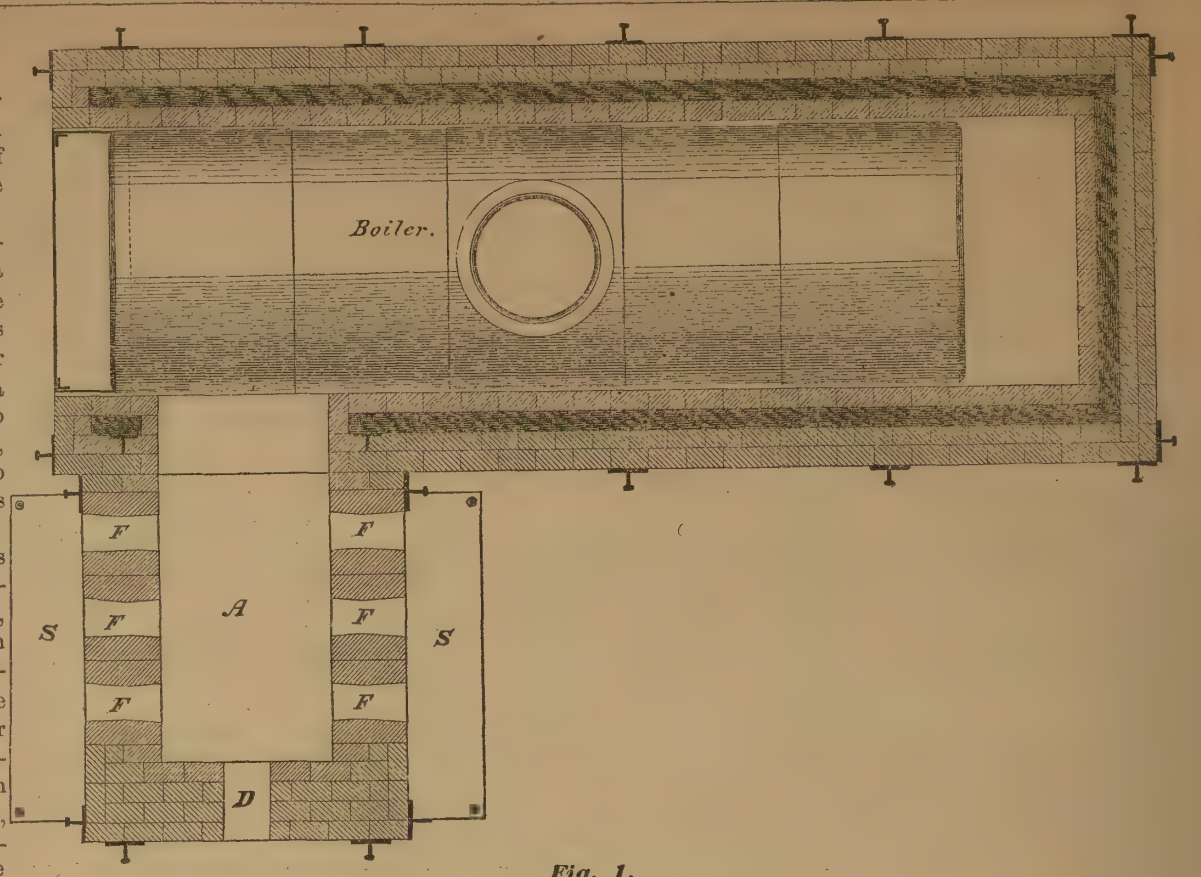


Fig. 1.

In these operations there is a large amount of inert nitrogen to be heated to the temperatures at which the oxygen combines with the hydrogen and carbon of the coal, and in this lies the principal difficulty of presenting the oxygen and combustible gases to each other at a sufficiently high temperature.

Upon newly firing an ordinary furnace with bituminous c al, as soon as the gases begin to be distilled, smoke immediately appears from a failure of either or several of the conditions just named; as an insufficient supply of air to meet the gases, a sufficient supply at too low temperature—a most prolific source of failure—a too abundant supply of air, cooling the gases below the temperature at which they might otherwise combine, an imperfect admixture of the gases and air before they become too cool in their passage to the chimney to permit of their combination, or which appears to be the most important of all, and heretofore the most thoroughly lost sight of—the production of large volumes of combustible gases *at too low a temperature* to combine, even if all other conditions are favorable to their combination.

The object of Mr. Hoyt has been to provide easy means for the regulation of the quantity, temperature and distribution of the air to be admitted both above and below the grate, or fuel, as well as to insure a properly high temperature for the distilled gases themselves as they are brought to meet the entering air.

It appears to be a well settled fact that it is entirely impracticable to pass sufficient air through the incandescent coke upon the grates to provide a sufficiency of oxygen for the complete combustion of the gaseous matter formed above it, for the reason that, if much more air is thus forced through the fire than is necessary for the perfect combustion of the solid carbon or coke, the latter combines with the oxygen largely in the proportions necessary only to form carbonic oxide, CO, and this only adds to the volume of the combustible gases above the fire, requiring still more oxygen or air to be admitted above the grate than when only the proper quantity is admitted through the grate; and this gas, CO, must be at a high temperature in order to still further oxidize it to CO_2, otherwise it would pass off unconsumed, although without adding anything to the volume of smoke produced.

It appears from the experiments had, that the result of too small a supply of air through the grate for the consumption of the coke, is merely to reduce the temperature of the fire and the rate of combustion on the grate; the fire smoldering and finally going out if the supply be too limited or sufficiently long continued so. The experiments also show that either too little or too much air admitted above the grates results in the formation of smoke, or an imperfect combustion of the gases; and they equally well establish that, both the air *and the gases* must be raised to a high temperature to insure the perfect combustion and absence of smoke; as well as that the admixture of them must be quite thoroughly done.

The furnace is represented in Fig. 1, in sectional plan, and Fig. 2, shows a vertical section through the oven or furnace and boiler. In the first figure, A, is the grate, D an opening in the brick work corresponding in position with the usual fire door, above the level of the grate, and having two doors, one within the other, the inner one perforated with a large number of small holes, so that air may be admitted above the coals at this point if necessary. S, S, are two shelves upon which the fuel is laid or piled preparatory to firing; F, F, &c., are small arched openings in the sides of the furnace with their bottoms a little above the level of the grate and through which the coal is fed. Above these are a series of small square holes o, o, seen in Fig. 2, through which air is admitted in a number of small streams from either side, regularly distributed over the surface of the grate. The walls surrounding the furnace and boiler are built hollow, and the air which is admitted to the furnace through the holes, o, o, is first made to circulate through this space. This construction subserves the double purpose of raising the temperature of the air before admitting it to the furnace, and somewhat cooling the outer walls, thus keeping the fire-room cooler by reducing the amount of radiation from the brick-work. The arch above the fire grate is considerably higher than in the ordinary furnace, and is also built hollow; the air on its way to the holes, o, o, circulates finally through this space, receiving its last and highest increment of heat therein. The products of combustion passes over the bridge-wall into the space under the boiler and return through the tubes into the uptake and chimney. The grate is 5 feet long, and 3 feet wide. The boiler is 54 inches in diameter, and 15 feet long; having in it forty-four 3½ inch tubes. The principal dimensions are as follows:—

Grate surface	15	square feet.
Heating surface	700	" "
Cross section of tubes	2½	" "
" " chimney	5	" "
Height of chimney	90	feet.

The grate is inclined from the side toward the centre to facilitate feeding; and for the same reason the openings, F, F, &c., are funnel-shaped, with the small end toward the fire.

The openings both above and below the fire are provided with iron shutters, by means of which the amount of air passing through may be regulated.

Below the grate and under the opening, D, is a similar one corresponding to the ash-pit door in the ordinary furnace, and this is furnished with a damper-door, by means of which the amount of air entering through the grate may be regulated.

With this construction it is evident that the volume of air entering the furnace either above or below the grate may be regulated to a nicety, while its proper distribution and thorough mixture with the gases from the fuel is very certainly accomplished; and so far the principal features do not differ materially from other devices in this direction, except, perhaps, in the heating of the air by means of the hollow walls on its its way to meet the gases above the grate; and this is a most felicitous arrangement. The method, however, of raising the temperature of the gases, as they are distilled from the coal, to the point necessary for their quick union with the oxygen of the air, is without doubt as novel as it is simple and effective: and consists in feeding the new coal *beneath* the bed of incandescent coke instead of on top of it, as is usually done. The coal is piled upon the shelves, S, S, and the openings, F, F, &c., are kept filled to the top, so as to practically exclude the cold air. When a new charge is passed into the furnace it is simply forced, by means of a rod of wood or iron, into and beneath the bed of coke upon the grate in small quantities, and the openings, F, F, &c., are again closed with a bank of coal. In this way the distillation of the gaseous matters goes on near the bottom of the bed of coke, and as they do not come in contact with oxygen until they have passed upward through the fire, they issue from its surface in their purity and very highly heated; and there meet the previously heated air.

That this heating of the gases is one of the indispensable conditions for their perfect combustion is amply proved by the fact that no variation of proportion, temperature or place of admission of the air to the furnace will produce a smokeless combustion in this furnace if the new charge be made upon the top of the hot coke, even in the smallest quantities; showing that the evolution of these gases is so rapid when distilled from coal distributed over the surface of the fire, that even with the intensely high temperature existing in this furnace, it is impossible to raise them to the temperature at which they can combine before they have passed beyond every heating influence, and into the flues or chimney. In the process of distillation, it will be remembered, a large amount of heat must be absorbed from the fire to supply that rendered latent in the transfer from the solid to the gaseous state, more than in the formation of vapor from a liquid as the transfer is here direct from the solid to the gas; and in the ordinary furnace this must be abstracted from the surface of the fire and the surrounding walls or plates, to say nothing of the additional heat required to raise the temperature of the gases to that at which they will combine. Being evolved in the body of the fire and near the bottom of it, the heat necessary to bring them to the proper temperature for combination is easily obtained in their passage through it, the bed of coke upon the grate being kept

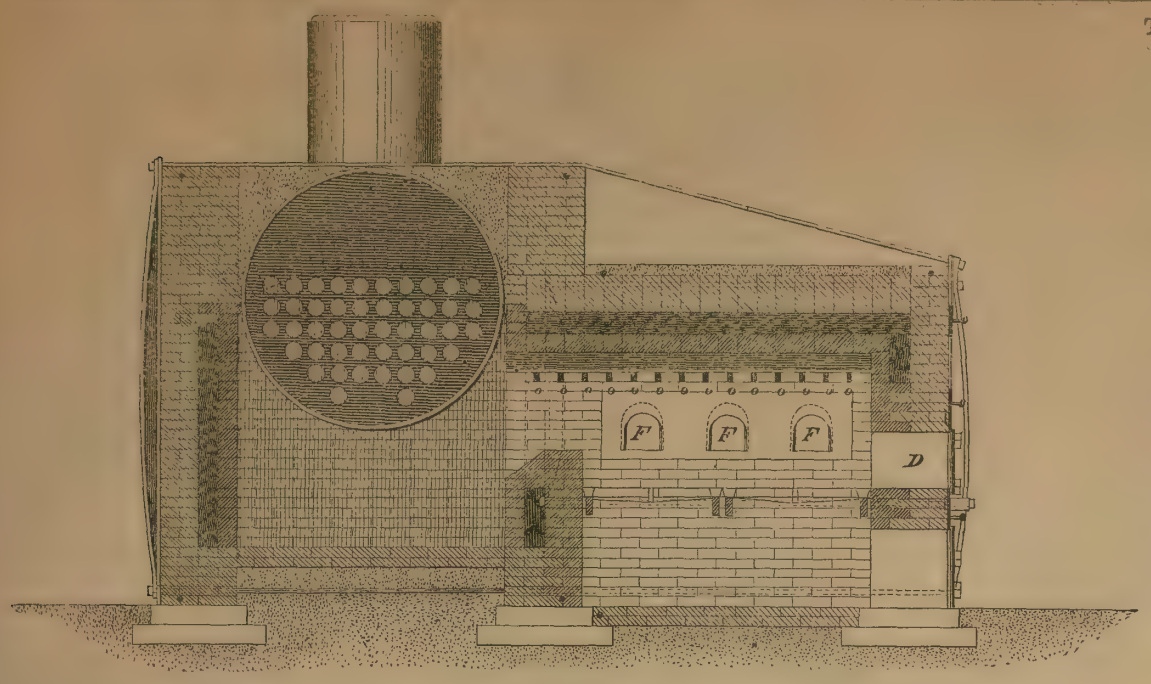


Fig. 2.

very thick for this purpose; averaging from two to three times the thickness allowed in the ordinary furnace.

In the regular operation of this furnace the arch over the fire reaches a very high temperature through the perfect combustion of the fuel, and thus adds largely to the final heating of the air and gases.

An interesting series of experiments has been made with this furnace and boiler at the belting manufactory of Mr. Hoyt, in New York, by Mr. Theron Skeel, C. E., and to a printed report of them (copies of which may be had upon application to J. B. Hoyt, 28 and 30 Spruce St., N. Y.), as well as to experiments made with the ordinary furnace for comparison, I am indebted for the illustrations, and much information regarding them. It would extend this paper beyond ordinary limits to give anything like a complete résume of these experiments; I will, therefore, mention only the most important results and facts connected therewith.

The first experiment was made September 7th and 8th, 1875, and had for its object to determine the economy of the furnace and boiler. The description, above given, of the furnace and boiler in the boiler-house of the Shoe and Leather Building, at the International Exhibition, will be correct for the one experimented on, except in some of the minor details and dimensions, and the type of boiler; the New York one being a flue boiler of the following dimensions:

Grate surface in square feet	15
Heating surface, in square feet	530
Cross-section of flues, in square feet—three upper flues	3.21
Do do do —two lower flues	2.14
Chimney at bottom do	5.32
Chimney at top do	9.21
Hight of chimney above grate...feet.	85
Ratio of heating surface to grate surface	36:1
Ratio of grate surface to cross area of flues—three upper flues	4.7:1
Do do do —two lower flues	7.0:1
Ratio of grate surface to cross-section of chimney—at top	2.8:1
Do do do —at bottom	6.1:1

Every precaution was taken for the proper measurement of the feed-water, which passed on its way to the boiler through a coil of iron pipe exposed to the exhaust steam *before* being measured. The coal was semi-bituminous, non-caking, from Maryland, of good quality, and was also carefully weighed; as also were the ashes and refuse in a dry state. Provision was also made for the determination of the quality of the steam with reference to the amount of water entrained. The temperature of the chimney was determined by a thermometer whose bulb was immersed in the ascending gases.

In the attempts to determine the temperature of the furnace, successive experiments were had, which, owing to the exceptionally high temperature, failed until a "tolerably close estimate" was made "from the weight of water heated in an hour in passing through a pipe exposed in the hottest part of the furnace." In the earlier efforts to arrive at this temperature, "the furnace melted successively when exposed in a crucible on the bridge wall, zinc, silver, copper, cast-iron, wrought-iron wire and finally the crucible itself;" and the writer has seen the ordinary fire-brick similarly situated, melted in the furnace at the Exhibition.

The average results deduced from the experiments were:

TOTAL QUANTITIES:

Duration of experiment (hours)	24
Pounds of coal supplied to furnace	5,015
Do ashes and refuse withdrawn	495
Do feed-water supplied to boiler	47,430
Pressure of steam by gauge	71
Number of holes damper was open	8

HOURLY QUANTITIES:

Pounds of coal consumed	208.9
Do do per square foot of grate	13.93
Do do do heating surface	0.394
Pounds of combustible consumed	188.3
Do do per square foot of grate	12.60
Do do do heating surface,	0.356
Pounds of feed-water	1,976

TEMPERATURES:

Steam (temperature due to pressure)	311°
Feed-water	135°
Chimney gas	560°
Atmosphere	70°
Boiler room	80°
Furnace (estimated)	3,500°

ECONOMIC PERFORMANCE:

Pounds of water per pound of coal from 135°	9.46
Do do do 212°	10.64
Pounds of water per pound of combustible from 135°	10.49
Do do do 212°	11.75
Pounds of steam per hour per square foot of heating surface from 212°	4.50

The quadrant of the damper was divided into 20 parts; it was therefore $\frac{8}{20}$ open.

From the ascertained velocity of the gases in the chimney and flues and their volumes, the weight of gases passing through the chimney in a given time was deduced. In this way the total heat developed by one pound of the combustible part of the coal consumed was found to be in pounds of steam from 212°:

Steam	11.75	74.6 per cent.
Gas, 2.23×500°×.24	2.77	17.5 "
Radiation, 233.3÷188.3	1.24	7.9 "
Total heat developed	15.76	100.0;

while it is probable that the equivalent of the combustible part of this coal was not more than equal to the evaporation of 17 pounds of steam from 212°, and possibly less. Assuming this, the loss from incomplete combustion is only about 4·6 per cent.

The temperature of the furnace, from a discussion of the experiments had, was estimated at 3,020°, but from comparison with experiments of Capt. Ericsson, made at the Delamater Works in 1870, it would appear to have been about 3,917°. Mr. Skeel, however, thinks this somewhat too high, not agreeing with the rate of transfer of heat at high temperatures as given by Ericsson's experiments, and places the temperature at nearer what was indicated by his own experiments, namely, 3,500°. He concludes that, *while never producing smoke*, the furnace, as indicated by this experiment, achieved a saving of about 7 per cent. of the heat ordinarily wasted with this kind of coal in the ordinary furnace.

A second experiment was made April 5th, 1876, with the same furnace and boiler, with the addition of a feed-water heater in the chimney, which showed a difference in the heat utilized in the steam as follows:

August, 1875, without heater	69.2 per cent.
April, 1876, with "	75.7 "
Difference	6.5 "

which was entirely due to the feed-water heater.

December 5th, 1875, a third experiment was made with a highly bituminous coal ("American Cannel") from Ohio; the object of which experiment was to ascertain whether this coal could be burned without smoke, and the amount of heat developed. The feed-water heater had not been added when this experiment was made.

The total heat developed by the combustible part of one pound of this coal, expressed in pounds of steam evaporated from 212°, was in this experiment:

Steam	11.69	70.8 per cent.
Gas	2.60	15.6 "
Radiation	1.05	6.9 "
Combustible gas	0.77	2.3 "
Vapor of water	0.44	4.4 "
Total	16.55	100.0 "

In February, 1876, a similar experiment was made with this coal in a boiler at the New York Hospital, having an internal furnace of the ordinary kind, with an abundant supply of air admitted through the partly open furnace door. This boiler had 27 square feet of grate surface, 100 cubic feet of capacity and 720 square feet of heating surface, the gases being very completely mixed in their passage through three sets of tubes. The distribution of total heat in this experiment was in pounds of steam as before:

Steam	9.56	57.5 per cent
Gas	1.90	11.4 "
Vapor of water	0.50	3.0 "
Radiation	0.60	3.6 "
Combustible gas	3·98	23.8 "
Total	16.54	100.0

Large volumes of black smoke were given off during this experiment.

These experiments show the comparative value of this coal for commercial purposes as burnt in Hoyt's furnace and that of the New York Hospital to be:

Hoyt's furnace	11.68	Proportion	122
Ordinary	9.56	"	100

giving an excess of 22 per cent. to the Hoyt furnace; to say nothing of the complete freedom from smoke in its operation.

Mr. Skeel considers the operation of the furnace in the New York Hospital to be similar to ordinary practice with that kind of coal, when consuming at the rate of ten pounds per square foot of grate per hour or more; and believes that the results obtained in the Hoyt furnace with this cannel coal, at the rate of twenty pounds per square foot of grate per hour, without smoke, would be equally economical with so slow a rate of combustion as five pounds per square foot per hour in the ordinary furnace of the flue or tubular boiler, set in brick-work, with very large grate and carefully fired in alternate sections, such as has given the best results, with Cumberland coal

The Polytechnic Review:

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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containing not more than 20 per cent. of the volatile matter; and it is well known that it is impossible to burn the highly bituminous Western coals, with from 30 to 40 per cent. of volatile matter, without much black smoke and a loss of combustible gas of at least 10 per cent.; and this under the most favorable conditions as to slowness of combustion and skillful firing; while in ordinary practice, the loss is much greater, and the volume of black smoke produced is immense. Mr. Skeel sums up his report of the experiments with the appended table, as follows:

"In conclusion it appears that while for the combustion of *semi-bituminous* coal the Hoyt furnace only offers a simple and efficient means for the prevention of smoke, and does not offer any advantage in economy over the ordinary furnace with slow combustion and great skill in firing, and only offers an advantage of 7 per cent. over the ordinary furnace with rapid combustion and ordinary firing, yet for the combustion of the highly bituminous coals of the Western States, such as 'American Cannel,' it not only offers an efficient means of *entirely preventing smoke* in the burning of the coals, but renders an increased economy of 13 per cent. over that obtained in the ordinary furnace with very slow combustion and the most skillful firing, and an increased economy of about 30 per cent. over that obtained with rapid combustion and only ordinary skillful firing."

For all stationary or land purposes, where bituminous or semi-bituminons coals are available, therefore, it would seem that this invention marks a decided step in advance, and will well repay investigation and trial by all interested in such matters.

In the furnace at the Exhibition, provision was made by means of windowed peep holes, for the observation of the different parts of the furnace and gas passages while in full operation, and professional visitors were much interested in observing the operations of the furnace in this way. The result of varying the supplies of air at the different points and of firing on top or beneath the bed of coals were readily seen, and Mr. Hoyt invites all interested to carefully examine for themselves. J. T. H.

THE SANBORN AUTOMATIC-CLAMP PAPER CUTTER.

As in every other machine a paper cutter, to be perfect, must accomplish much work in little time and reduce manual labor to a minimum; in a paper-cutting machine the points that require immediate attention are speed and durability—speed, the more important, to enable profit at the now existing competitive prices for work; and durability, to sustain the immense wear and rough usage to which they are subjected.

To attain speed in operation a self-clamping attachment is of first importance, provided it is thoroughly automatic, always ready for use, does its work quietly, and possesses the great merit of durability. The Sanborn clamp appears to embrace all these points, and, if this be true, stands alone as an invention highly meritorious and new; a careful examination of the machine as a whole will better enable a correct judgment as to its merits.

The cutter is of the Sanborn "Diamond" pattern, which is generally considered one of the best ever built, and has been so successful as to obviously warrant the claim that with the automatic clamp it will do more work with less manual labor than any machine heretofore put upon the market.

By reference to the cut the general design of the machine will be found pleasing to the eye and calculated to provide great strength where required. This provision of strength secures that accuracy or trueness of cut so necessary to render the upper and lower sheets identical, preventing any variation of the knife from the strict vertical. The knife is operated by a mechanical movement that developes immense power and is strictly positive in motion, bringing the knife always to the same point without regard to size of cut, and is withal, noiseless in operation, as is the whole machine.

The main shaft is provided with a simple coupling worked by lever at right hand or foot, which applies power to the machine and automatically suspends after the cut is made, or can be given a continuous motion, as is frequently done in trimming pam-

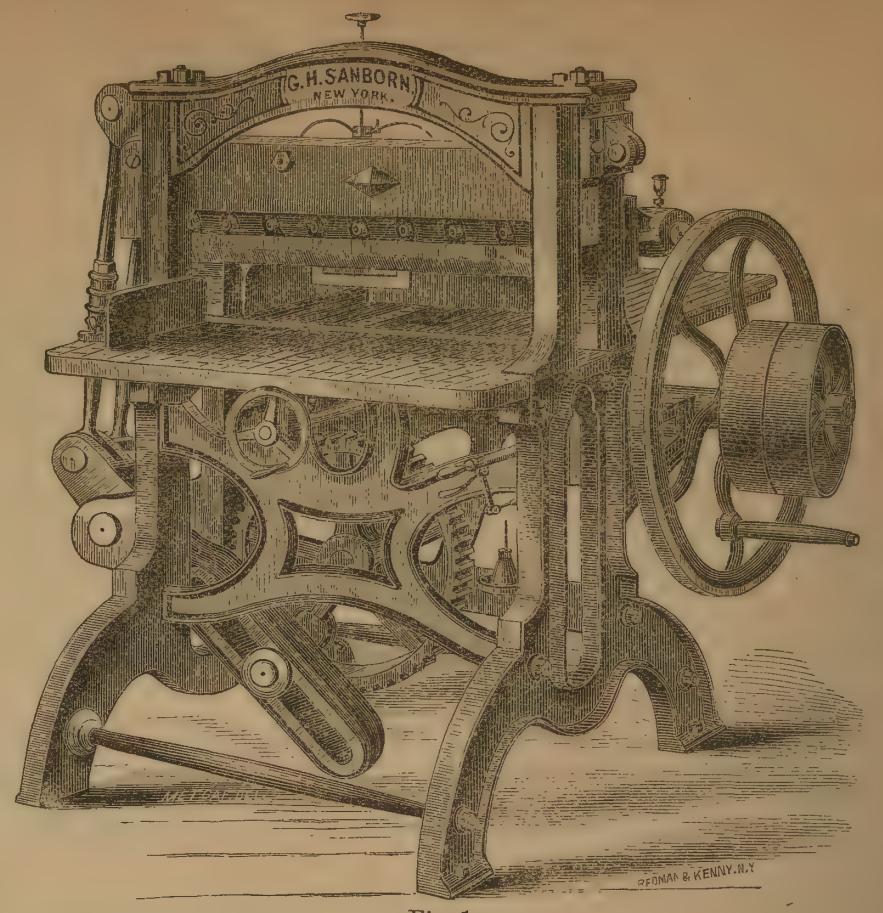

Fig. 1.

phlets or in long runs of gauged work. The power is applied by bevel wheels to a minor cog which works in the large one, shown in the cut, containing the pinion which elevates the slotted lever; the pinion travels in the slot continually depressing the knife for about three-fourths the revolution of the wheel, then reverses and returns the knife to its first position. This causes the knife to descend slowly and return *quickly*, saving much time and completing the operation therefore sooner than other machines. The knife bar is perfectly balanced and can be stopped at any point by simply removing the power; there can be no danger from dropping of the knife or premature movement. The knife has an adjustment in the bar which provides for variation in the cutting-strip or defect in the grinding. The bearings throughout the whole machine are well made and calculated for service, the gauge parts being finished to allow accurate adjustment and insure a square cut.

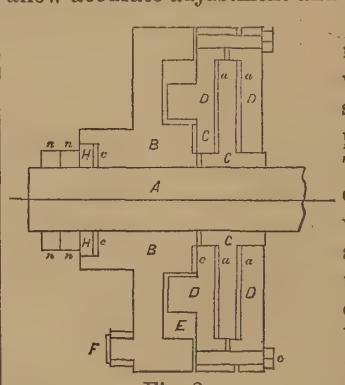

Fig. 2.

The clamp is very ingenious; it requires no adjustment whatever on ordinary work, clamping equally well a single sheet or five-inch pile, although the pressure can be regulated when required. And these two points are considered the desiderata in all self-clamps. The clamp apparatus, simple but complete, may be understood thus: in the cut, at the back of the knife-bar will be noticed a journal, which holds a shaft running across the machine, furnished at the opposite end with the appliance shown in fig. 2. This consists of a tight disk, C, surrounded by two others, D D, which are bolted on by screw e; between C and D, two leather friction surfaces, a a, are placed; B is a loose disk which is connected directly with the slotted lever by the rear pitman shown on the large cut at the left—hence the power to work both knife and clamp is derived alike and perfect regularity secured; this connection is made at pinion F. At E is a ratchet that engages D and D on the depression of F. When the cut is made, B is turned down with the knife, engaging D, and, through friction, turning the tight disc, C, and shaft, a; the shaft is provided with segmental cogs which lower the clamp. Upon placing a pile of paper under the clamp and starting the machine, the knife and clamp will move together until touching the work which is bound with sufficient force to overcome the friction at a a, while the knife and disks, B and D continue to descend. The pressure is regulated at screws, e, which increase or lessen the friction. The ratchet is dispensed with on the raise, sufficient friction being gained at small bearings, c and c, which resemble a a; the requisite pressure is made by nuts, n n, forcing up H, which is slotted on to the shaft and assists in turning it up, causing friction at all the points, c.

The clamp is thus seen to be truly automatic—the operator merely places the work and removes it after cutting. A very important assistance is found in the cut-gauge which is seen in the large drawing depressed below the clamp, of which it is a section accurately made, and can be brought down on the work by the rod shown above it and designate exactly where the cut will be made. Again the clamp stands just ahead of the knife, protecting the operator from its edge. Another good point is in the back gauge, which is made in sections so as to trim three sides of pamphlet or cut more than one gauge. In binderies this is eminently useful, and is only one of the many small features that go toward making a perfect machine.

The automatic clamp may be seen at the salesrooms No. 25 Beekman Street, New York, at any time. An examination cannot fail to be of interest to those using paper machinery; it is adapted to all sizes, and costs but little more than the regular machine—say $50 more. While some criticism could no doubt be made, this paper-cutter, as a whole, is undoubtedly excellent and seems to fully warrant the high claims made for its superiority. The clamp descending just ahead of the knife; the automatic

binding of the work, sure and positive; the descent of the knife obliquely, driven by immense and unvariable power; and on its return with a quick stroke, the release and raise of the clamp, and return of the whole to the first position, attracted much attention at the Centennial Exhibition and gained an award that seems to be the most commendatory given to any paper-cutting machine, as an entirety, there exhibited.

H. C. HUNTER.

"TEN MINUTE" PAPERS.*

BY PROF. J. E. SWEET.

II.

TOOLS AND THEIR USES.

(In writing this series of papers on tools I ought perhaps to begin with those for wood-working; but as the iron-working tools more nearly concern us at present I will first speak of them, leaving the wood-working ones for an appendix, should our success justify it.)

The first tools we have to deal with are the hand tools, principal among them the hammer, chisel, file and wrench. These, although of late largely superceded by machine tools, are by no means dispensable; and the workman who can handle them deftly can command better pay than he who can not; besides it is one of the first things which an employer or foreman notices in a new workman when judging of his ability. It is much cheaper to buy a good hammer, now that they are manufactured and in the market, than to make one; still some prefer to make their own, and there are one or two facts worth knowing.

It is not of as much importance whether the eye is an oval or a rounded slot, as it is that the eye is largest at the outside, curving in toward the center and curving out on the opposite side as in Fig. 1. With an eye of this form the part of the handle entering may be left considerably larger than the eye and yet forced in. The wedges on the opposite side expanding the wood, give a far more secure hold than is possible to get otherwise. The handle should be left larger and smaller at the points shown

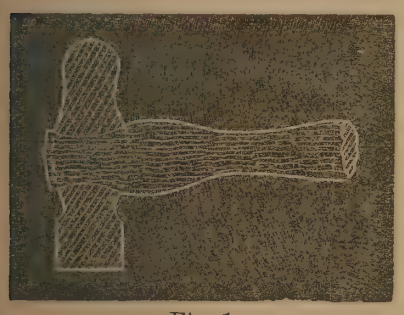

Fig. 1.

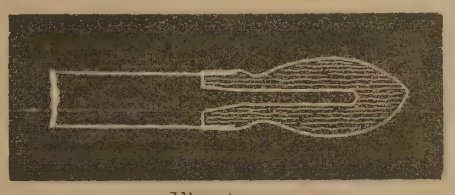

Fig. 2.

in Fig. 1—the first to prevent its being driven through the eye, and the second to give it elasticity. There is another advantage in using a trade hammer rather than one of your own make—you are likely to think more of your own than of any other, and make a practice of using it exclusively, so that if in case of emergency you have to use another, it seems awkward to you.

Better skill yourselves in striking with all kinds of hammers and in all positions; for, to get the best and most varied experience, each of you must make a sort of universal machine of himself; you must be able to strike lying on your backs or standing on your heads; right hand or left hand, and with anything that best serves the purpose. It is not, as a general thing, policy to use a monkey-wrench to pound with; but it would be economy to spoil a monkey-wrench worth fifty cents, if it answered the purpose, rather than to spend a dollar's worth of time in going for a hammer,—although very poor economy if you could get a hammer for a quarter. In using the hammer the beginner always holds the handle in his hand with a firm grip; the experienced workman, never.

Cold chisels, that is chisels for cutting metal, are of various forms and sizes, suited to different kinds of work; but the majority are known as flat, cape and round nose—the first wide for flat surfaces, the second, thin and deep for cutting channels and mortices, and the third similar to the second, but with one side rounded to chip out holes, curved corners, etc. In tempering they are first hardened and then partially softened by heating them until the color of the bright surface turns purple blue. After grinding, the edge should always be ground square off—a little on the very smallest ones, and more on those used for heavy work. The edge, if left sharp, will either turn over and make the chisel slip, or it will break or crumble off; and when it breaks it does so higher up than it would have stood if ground off in the first place.

I will attempt to say but little in the way of files, except that each should have a well fitted handle; and for a given purpose I know of nothing more utterly unsuited than the tangs or shanks of files as universally made. By remodeling the tangs of our entire lot of files, I hope, during the term, to show and convince you that there is a good form as well a bad one; although I feel sure that a quarter of a century at least will be required, (our graduates holding prominent positions,) before a general move can be made to change the wrong for the right. As they are now made, they are expensive to forge by hand, and very difficult to forge by machinery. There is no tool by which a proper hole can be made in the handle; nor can there, while they are of all sizes and degrees of taper, be such a tool made. Besides the tangs will not, even if put in in the best manner, stay in a handle as they should. There is no more sense or economy in changing a file handle every time one wants to change a file, than there would be in so changing a hammer handle; and if the tangs were of such form that when a handle was put on it would stay, workmen would no more think of shifting the one than changing the other. That part of the tang next the file where the handle is protected by the ferule, should be tapering to give it strength, is all right; but that the part back of the ferule should be parallel, or nearly so, and of such size that it will drive tightly within a standard sized hole, is in my opinion the true form; as shown in Fig. 2, the handle, to be used a long time without cramping the hand, should have a good deal of convex surface and very little, if any, concave; and there should be no beads or ornaments. The wood from which they are made should be thoroughly seasoned, or the ferules threaded on as a nut is screwed upon a bolt. Gas pipe, threaded on the inside and cut into short lengths, makes durable ferules. Files are cut their whole length; and to use only a small portion in the center sacrifices half their value. The best practice is to run them their entire length at each stroke, running them at a steady uniform speed—not too fast; and to exert sufficient pressure to make them cut from end to end. If a file is run too fast, or allowed to slip over, it wears away the teeth; a pretty well worn file will cut if held to the work with sufficient pressure; and for steel (unless the file is made specially for it, with obtuse teeth,) it will endure more if used first on softer metal. The teeth of a new file are rapidly broken off, unless used with care.

The diversified practice of years ago, and the bungling attempt to establish a uniform system of sizes for the outside diameter of bolt heads and nuts, has so filled our shops with these bolt heads and nuts of all conceivable sizes, that to get along without the monkey-wrench would be impossible; and were a simple system in universal use, it would still be a desirable tool for jobbing purposes. There are many good patterns in the market; none quite perfect and none half well enough made. They should be made entirely of the best tool steel, except perhaps the handle, and I am not sure but that ought to be a metal shell. A great defect in all of them is the lost motion. This can only be remedied by using enduring steel instead of yielding iron. Most wrenches will stand the strongest man's use if they are *set up tightly* to a square or hexagon nut and used the right way; that is, with the open end of the jaws toward you when pulling, or from you when pushing. But, owing to the slack motion in the screw, they are not always set up tight, and besides it is not possible always to use them the right way. Often, nuts are so located in a flanged corner that it is impossible to turn them with a monkey-wrench without holding the wrench wrong; it is in this way that they are over-strained, bent and often ruined. Always use the wrench the right way when you can, and the wrong way only when you must.

The time may come when some of you will wish to embark in business, and may question what this shall be. Unless the field is supplied before, I have faith that files equal to the best made in other respects, and with tangs of the proper form, can command the market. A good tang will not sell a poor file, but would advertise and create a demand for a good one. He who manufactures of the best tool steel monkey-wrenches of unexceptionable design, with workmanship equal to the best gun work, can build for himself as good a business and as great a reputation as Madole made for himself in the manufacture of cast steel hammers. It needs no invention or patent; any one of the old standard patterns fills the bill; but the very best stock, the use of the most perfect tools for forging and finishing, absolute honesty in the manufacture and sales, and business energy, will certainly succeed. The cost of these steel wrenches, at the most, can not be over twice the cost of iron ones; and it is just as unreasonable to say people would not pay a dollar and a-half for a steel wrench when they can get an iron one for half a dollar, as it would be to say that they would never pay a dollar and a-half for a steel rule when they can get a boxwood one for a "quarter." Solid wrenches should always be used on finished nuts; and had not the Philadelphia tool makers adopted one size and the United States Government adopted another which is used by the Eastern tool makers, we could get along with fewer numbers than we are now compelled to have. If the common solid wrench were a perfect fit, then the nuts would need to be absolutely of the same size; and owing to the impossibility of so making them of case-hardened iron, it is necessary for the wrench to be a little loose, and this brings the strain wholly on the corners. To obviate this I have devised the wrench, Fig. 3, which we use on our engine, and which is the only

Fig. 3.

one I have seen that will fit a nut perfectly, and yet go on easy; but the great objection to these wrenches is that a person unaccustomed to their use is sure to turn them the wrong way. Though I designed and made a few of these ten years ago, it is only within the last three months that a plan occurred to me to overcome this defect by making the edge of the handle that is to take the pull round and smooth, and the other edge sharp. The workman will not be liable to do serious harm to either the nut or the wrench by turning backwards.

I ought to refer to taps, dies and reamers; our standard tools, calipers, scrapers, etc., but as on most of these things I have had much to say heretofore, and as I shall have occasion to mention the others as I proceed, I will turn to *Machine Tools;* and will begin my next paper with the most indispensable of all.*

By the exclusion of trivialities, and of all matter having a peculiarly commercial bearing, we have rapidly built up the reputation and the circulation of the REVIEW.

"FAIR AND SQUARE" will be found to be the motto of the conductors of the REVIEW, both in matters editorial, and in business dealings. To give contemporaries full credit for items borrowed, and customers more than was promised, is our intention and practice.

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*Read before the Mech. Eng. Association of Cornell University.

FILES AND FILING.

By JOSHUA ROSE.

The file is one of the oldest of tools of which we have any knowledge, nor is there any probability that its employment in the mechanic arts will do other than to maintain its position, for the simple reason, that properly made and in skillful hands it will perform a duty unequalled, for truth and smoothness, by any other known tool. It is an utter fallacy to suppose that the introduction of either fast running grindstones or emery wheels have encroached upon the legitmate domain of the file, nor can they ever do so, for the use of these abrasives has only diminished the number of cases in which files were put to a rough and destructive duty by the reason of the non existence of any other tool applicable to the case, and even here the file holds its own in a large majority of instances, because it is a tool complete in itself, independent of steam power, and can be used in any position, and under almost any conditions. It is folly to tell a really good mechanic that a file can be dispensed with in the ordinay production of good work for the reason that machine-cut surfaces are not cut true. Let us start with the milling machine. It will produce and reproduce work of peculiar form with a reasonably good fit, and with accuracy of outline and dimensions, but the surfaces are not true, and we have never yet seen the piece of milled work, even though got up for especial exhibition, that could not be improved by the file, in skillful hands, both in fit and finish. If any one wishes to satisfy himself upon this point let him take any piece of flat milled work, such as a connecting rod key, and test it upon a surface plate, and he will find that it is not true, and furthermore. that it will take considerable filing, using a twelve or fourteen inch flat smooth file, to bring it to a true surface. This same fact also applies to planed surfaces; nor need we look far for the reason. To hold a piece of work sufficiently firm to be able to operate upon it in a machine, we must place it under considerable strain or pressure, and this springs the work out of its natural form, and so soon as it is removed from the machine, that is to say, released from the pressure, it springs back again to its original form; and the file is the only known tool that will properly correct the evil. It is easy to claim for machine-finished work all the excellencies pertaining to file fitted work but the surface plate or any equivalent test will pronounce such claims untenable. It may be true that we may fix our standard of excellence at such a point that machine-work will fill its measure; but this is in no way desirable or even profitable, because a piece of work that fits, so far as there being no lost motion is concerned, will nevertheless get lost motion from wear, in precise proportion to the area of surface in contact, or in other words, in proportion to the fit, and as an illustrative example, we may note the fact that Mr. Brown, of Fitchburg, Mass., had an engine running, at the Centennial Exhibition, with the slide spindles and stuffing boxes such a fit that they are steam-tight without the use of any packing, running tight for months.

The file is not by any means the rude instrument that the ordinary observer would suppose it to be; every part of its manufacture requires the greatest of care and skillful manipulation, and even then the hardening may often partially destroy its value, by warping it more or less; and so important is this element, that the success obtained in the past by the Stubbs and Grobet files has been very largely due to the correctness of their outlines. A file should be of an even sweep from end to end, and while it is all that is neccessary to have it bear evenly across its width, it is an improvement, if the teeth are a little higher along the middle of the length of the file, but in no event should it be hollow in its width, for it would then at every stroke file two grooves.

To produce files by machinery, and equal to those cut by hand, has been a problem, to the solution of which the mechanical world has directed continuous effort for many years past, and in working it out success has been but slowly attained. As an unfortunate consequence workmen have a prejudice against machine-cut files, which prejudice is not warranted, in view of the quality of such files as are at present made. There is much to excuse in this tenacity with which the workman has clung to the hand-cut file, for the claims put forward on behalf of the machine-cut files at a time when their manufacture was in its infancy, and mere experiments in fact, have caused the workman to employ excessive caution in according to them the credit due to their merits, or in other words, the failures of the past are a load which the manufacturers of the present have to carry. That this load is becoming lighter, there is no doubt, and there is every reason to believe that the time is not far distant when machine-cut files will be the rule and hand-cut the exception. It is the users of the files who require convincing, that is, the actual operatives. The writer himself, after over twenty years experience, and many trials, had come to the conclusion that the day was far distant when the reputation of hand-cut files would have anything to fear at the hands of its rivals. A close inspection, however, of the exhibits at the Centennial Exhibition, demonstrates that so far as the eye and judgment can determine, the machine-cut file will bear the closest comparison with its rival, and this is more than we can say for any of the machine-cut files he had in previous years inspected.

Among those exhibits, that of the Nicholson File Co.'s is prominent, not only on account of its size and completeness, but also for the reason that it contains the only variation to the form of the cut of a file which modern times has produced. This variation consists in giving to the file what is called an increment cut, that is to say, the depth and width apart of the teeth are made variable, as well as their heights, and the theory upon which this method of construction is evidently based is as follows:—

The amount of cut a file will take at a stroke depends upon the amount of area of cutting edges in contact with the work and the pressure placed upon the file; it follows then, as a general rule, that the less the area of cutting edge (under a given amount of pressure) the greater the amount of metal removed. Now if the file teeth run in such regular lines that they cut grooves, the area of the cutting edge in contact with the work increases proportionately, and the cutting duty is diminished. This fact is recognized by all expert workmen, in the fact that upon all broad, or comparatively broad surfaces, they resort to expedients to overcome the regularity of even hand-cut files. Thus, for instance, in filing up a broad surface where the ordinary file handle is replaced by an iron "raised handle," which will allow the tang of the file to pass over the work, the mechanic, if he wants to remove a quantity of metal, casts his eye down the length of the file and selects the side most rounding in its length, and as a consequence only a comparatively small area of file teeth can come in contact with the work, and by raising or lowering the handle he can first use the end, and when that gets dulled, the middle and so on of the file. He finds, however, that this increases two existing defects, that is, the file cuts grooves, or channelings as it were, which causes the cutting to clog in the teeth, and this is called "pinning." The cutting is also impeded by the large area of cutting edge in operation. To remedy these two defects he files so that at every few strokes the file marks cross each other; even on ordinary or small work he does this. The evil of "pinning" is a very serious one, for the pins prevent the file teeth from cutting by obstructing their contact with the work; then again, a file card will not remove them all, and hence the small strips of sheet-brass, flattened out at the end, and with serrated edges, which are to be found on all machinists' vise-benches, and which are used (to remove the pins) by being forced across the width of the file, and in a line with the rows of teeth. This process injures the file teeth by dulling them, because the brass meets the edges in a line with their fibrous edge, and thus in a direction in which that edge is in a measure unsupported. In smooth filing and draw-filing "pinning" is very disadvantageous, because the "pins" cut scratches in the work, and it is no exaggeration to say that in fine work it takes more time to guard against and remove the scratches thus produced than it would otherwise take to do the whole finishing. To prevent "pinning" when using files subject thereto, the workman takes two methods, first, he may keep the file well oiled, but this keeps every tool about him dirty, and entails constant attention in oiling and cleaning the file; hence it is much more common, and better, to well chalk all the file teeth, and after every few strokes to brush the hand over the file, and tap the same on the screw box of the vise, which removes part of the chalk, and with it the filings; then every few minutes fresh chalk is applied. In filing thin metal such as sheet-iron, plate-iron, or saw-blade, "pinning" is an especial nuisance and great defect, because it interferes with the operation at every few strokes, providing much pressure is placed upon the file, and this is a consideration that applies especially to the use of mill-files and smooth-files, whether the latter be used to draw file or to cross file, for the workman will prefer to use the file very lightly rather than be subject to the annoyance of having to remove the "pins" from the file. Job's patience was never really tried, for he never had a fine piece of work to be finished with a file liable to "pin."

The object of the increment cut is to ensure that the rear teeth shall remove the projections made by the front ones, and not cut in the hollows, and this, it is claimed, it so effectually does as to remove the "pinning" difficulty to a considerable degree, and at the same time permit the operator to employ as much force as he desires upon the file. The subject is an important one and we shall not lose sight of it.

FIRE ESCAPES.

I.

As people *must* erect high buildings, and *will* build them with inadequate and insufficient means of access to their upper stories; and, furthermore, as they cannot or will not make these buildings fireproof, it follows that fires will and do occur; the access to and from the upper stories will be cut off, and lives and property exposed to risk and loss—pent up in a fiery furnace, too far to reach the ground and safety by jumping. Consequently means of rescue must be provided; so that the hale and the halt, the athlete and the invalid, alike may find refuge or be brought to safety. The ingenuity of inventors has been largely taxed to devise such means of escape; and it is to be regretted that as yet their efforts have been crowned with only partial success. It is true, there are many results to be attained under limiting conditions. A fire escape should be light and strong, quickly reached or applied; must protect more than a limited portion of the building; must not be complicated nor easily deranged; must serve for the protection of the old and feeble, the young and helpless, women and invalids, and the able-bodied, who, under the excitement or bewildering effort of the moment, are worse than helpless. If possible, the fire escape should be cheap, so that legal enactments need not be resorted to, in order to compel its use.

The perfect fire-escape has not yet been produced; but there are some excellent ones now in use, and which ought to be more generally adopted.

"When night comes, in London, one sees along the principal streets, advancing slowly in the fog, immense and light iron ladders, solidly mounted on wheels, and carrying three red lanterns. This curious apparatus is a *fire-escape*, put in motion by a fireman, who pushes it before him to its regular place at the crossing of two streets, where both will pass the night ready for any emergency; the fire-escape high in air, the fireman beside it, in his sentry box.

If, at Rouen, during the burning of the Theatre of Arts, the corps of fireman had possessed a single one of these fire-escapes, which could be so easily operated, placed in any position, and would reach the roofs of the highest houses, not one of the unfortunate victims would have perished. Why had they none? The fire-escape has been in London for several years past; there, its place, from six o'clock in the evening, until six in the morning, is at the street corners, where all passers can examine, study and draw it.

Moreover, London is not situated in Central Africa. Many Rouennians frequent it, some indeed live there, who must have spoken more than once of the fire-escape, to their compatriots. But routine is a beautiful thing!" [*Translated from the Revue Industrielle.*]

G.

BREAD UPON THE WATERS. So many generous inventors and others offer to distribute to possible subscribers (*free*) copies of the REVIEW, containing articles in which they are interested, that we must remind these that we can circulate copies to much better advantage, ourselves. We send out a number of agents, each with copies under one arm and a subscription book under the other. Furthermore, scarcely a letter goes out to a non-subscriber, from this office, or from any of its branches, which does not have attached prominently thereto, a small colored slip or "hint," (familiar to many of our readers) reading as follows: "It would afford us pleasure to place your name on our subscription list. Price, *per annum*, including U. S. postage, $3.00, in advance. Address "Polytechnic Review," 119 South Fourth Street, Philadelphia." A record is kept of each "hint" sent; and the remittances are checked thereon, as they come in. The proportion of subscriptions thus obtained very much exceeds the probable result by the *other* method. We cast a great deal of "bread upon the waters;" but we prefer to use a hook and string with each piece, so that when the bread returns, there is something else with it.

PROGRESS IN SCIENCE AND THE ARTS.

ENGINEERING—CIVIL, MECHANICAL, &c.

Fuel and Motive Power.—Of recent years great improvements have been made in what is known as the "economy" of engines, and though our best results scarcely surpass those obtained years ago with pumping engines, we may well be satisfied with the progress made thus far, for modern steam-engines are rarely working under conditions so favorable as those which generally obtain with pumping engines. But in spite of all the attempts that have been made to obtain an approach to the theoretical value of fuel, the results are so far unsatisfactory that some inventors and engineers have turned their attention to the utilization of other motors besides steam. There are several air engines, at least three gas-engines, and a petroleum-engine (which is practically a gas-engine); not to mention the water engine, which latter, however, is dependent on certain special conditions. If we compare different fuels, and assign them a value for heating purposes based on their chemical constitution, we shall find that petroleum is about 25 per cent. superior to all others—*e. g.*, theoretically and in round numbers petroleum is capable of evaporating 16lb. of water per pound of fuel, while a pound of coal can evaporate only 11½lb., and a pound of coke only about 10lb., these fignres varying to a certain extent in accordance with the different qualities of the fuels. As used in practice, however, it is found that the average evaporative power of petroleum is 13lb. of water per pound of fuel, of coal about 8lb., and of coke the same—that is, when burned under fairly economical conditions. With the general run of steam-boilers, 50 per cent. of the theoretical heating power is lost, and probably more, through imperfect combustion, radiation, and other causes. The straw-burning portable engine when tested at Vienna gave a good result when the effective heating power was compared with the theoretical, only about one-third being lost; but that was an exhibition engine, and was worked by skillful attendants. Of other kinds of heat-engines only those working with hot air, exploding gas, and exploding petroleum vapor, have proved of practical utility. The Belou-air-engine shows an effective of from 4 to 6, if we take the theoretical constant at 10, while Ericsson's only gives 2. Of gas-engines Otto and Langen's show an effective heating power of from three and a half to six-tenths of the theoretical power of the gas reduced to coals. This appears to be the most efficient gas-engine, but is beaten by the Hock petroleum engine, which has an efficiency of from 4·6 to 8·4. Accurate statistics of the efficiency of various engines are, however, difficult to compile, because information of the special conditions of the test experiments are not always supplied. It may, however, be taken as fairly trustworthy that while the efficiency (utilization of theoretical power) of steam-engines ranges from 1·8 to 9, the best form of gas engine is represented by 5, the best air-engine by 4, and the petroleum engine by 8. The cost of fuel in gas-engines is, however, so much in excess of that in any fairly well designed steam-engine that, except under special conditions, the latter is not likely to be supplanted. While there are obviously limits to the size of the gas-engine—because in a large one the "economy" would be reduced by an unavoidable waste of power—it is unquestionably an admirable motor where the work is irregular. And as to the air-engine, and more especially the petroleum engine, too little is known of their practical working to arrive at any judgment upon their merits. [*Eng. Mechanic*, xxiv, 255.]

The New Amsterdam Ship Canal.—The London Times makes the following comments upon the lately completed Amsterdam ship canal. The work was thrown open to commerce on the 21st of November, and cost about $10,000,000.

Amsterdam, which sprang into sudden importance when the Spaniards had ruined Antwerp, had begun during the last few years to see before its eyes the danger of its joining the melancholy sisterhood of the dead cities of the Zuyder Zee. The channels by which the riches of the world were once brought to Amsterdam, to be reshipped at the profit of the Dutch capitalists, have become too shallow for the great vessels of burden which carry the merchandise of modern days, and even the spices of the Dutch East Indies, the coffee of Java, the sugar, indigo, tobacco and rice from the tropical dependencies of Holland in the East and West go now, by preference, to Rotterdam, which has long been growing at the expense of its more famous neighbor. The old route from Amsterdam to the ocean was by the Zuyder Zee, but the storms and the sandbanks of this dangerous gulf led, in 1819, to the construction of the North Holland Canal from Amsterdam to the Helder, the northernmost point of the province of North Holland, over fifty miles from Amsterdam. Why this route was chosen instead of the short cut now made is hard to understand. But provincial interests prevailed over the claims of the mercantile capital, and it was reserved for our own days to bring Amsterdam by a cut of 15 miles within an hour or two at ordinary tides of the German Ocean. What the effect will be upon the commerce of the world must be left to time to determine The citizens of Amsterdam possess shrewdness enough to offer a formidable competition to any rivals in trade, and they possess great accumulations of capital. It takes one or two days for large vessels to reach Amsterdam from Neiwuediep, as the port at the Helder is called, and they often suffer much delay from contrary winds. They cannot come at all till they have been relieved at Niewuediep of part of their cargo, which is sent on by lighters. The result is that charter parties often contain an express stipulation to the effect that though the vessel may be ordered, perhaps, to any port of the British Isles or on the Continent of Europe between Havre and Hamburg, she will not be compelled to go to Amsterdam. The new canal will probably put an end to this invidious exception,

American Tools.—Dr Anderson, one of the British judges and Chairman of the Board of Judges at the Exhibition on Machinery and Tools, has contributed a series of interesting articles for the London *Times* upon the machinery display at Philadelphia. In the course of one of these articles he pays a tribute to the superiority of American machine tools. He says the section which most conspicuously brings out the enormous strength of America as a producing power is that of tools, especially the machine tools for metal, the parents of all other machines. These tools he describes as being designed for all purposes, and adds that almost all are finished in a style superior to that of any former exhibition. The new departure taken in punching metal by the machine exhibited by Hoopes & Townsend, of Philadelphia, he says "has created a sensation among engineers of all countries, the United States included. The nuts punched by the machine have two peculiarities—they are of inordinate depth and are punched cold. Nuts 1¾ inches in depth have a ⅜ inch punch passed through them." The doctor speaks of the admiration caused by this achievement, and of the skill shown when the secret of how it is done leaked out. He says the fluid property of cold iron or steel is taken advantage of by introducing the element of time into the performance of the operation. The punch is given only the pressure it can sustain, and then nature being allowed its way, the instrument penetrates at a rate proportionate to the flowing of the mass. Whilst the experimentalist and the philosopher have been writing of the flow of solids, the natural law is here made use of practically. "Unimportant as it may seem, yet vast issues are bound up therein," writes Dr. Anderson, [*Iron Age* xviii, *No.* 23.]

Railway Construction.—The era of railway construction has by no means passed by, though it is for a while under a great cloud. The world is not yet supplied with railways sufficient to meet its growing wants, nor will it be during the present generation. Europe and America have made vast and wonderful progress in this respect during the last quarter of a century, but we predict that they will make still greater during the next twenty-five years. Even now the ball is beginning to roll on with increased rapidity. Our readers must have noticed the large number of new projects broached in this country. Most of them have the feeble look of infancy, but many are healthy and promising. In other portions of the world, the indications of increasing activity are really surprising, as will be seen by the partial summary of new enterprises in foreign countries, given in another column. The people of the United States, with their vast resources, their sanguine disposition, and natural elasticity, will not be the last to recover from the depression.

But in three quarters of the inhabited world railways have hardly as yet acquired a foothold. Asia, Africa, South America and Australia offer almost boundless fields for a development which is not to be regarded as a bare possibility, but as a certainty. That development is even now taking a fresh start. The manufacturers of Europe are interesting themselves in making markets for their goods in new fields. The manufacturers of this country, so far from being discouraged, should be preparing for taking their share in the great work of railway building in all quarters of the globe. The home market is now assured. Time was when we, like the Italians, used the words "foreign" and "excellent" as synonymous. But that day is passed, and we should now have confidence enough in ourselves to become aggressive. The tide is in our favor, and if taken at the ebb will lead on to fortune.

We have, heretofore, called attention to Brazil as a promising market. Some of our locomotive and car builders have been and are now doing considerable business with that country and the West Indies. American street cars are making their way into many foreign countries—even into the manufacturing centers of Europe. This trade may be retained and increased, and may be participated in by manufacturers of other railway supplies. Mr. Greeley once said that "no country could hope to transact a large commerce until it found itself with a large surplus of manufactures and under the necessity of exploring the world for places to sell them." That time has come for the United States. The necessity may lead to glorious results. A step which will faciliate intercourse with South America is now under consideration, and we hope will meet with success. We refer to the establishment of two steamship lines between the United States and Brazil. But whether or not these and kindred enterprises succeed, the time for "exploration" has come, and if we do not use our advantage, others may step in ahead of us and reap the reward of their pluck and enterprise. [*Chicago Railway Rev.* xiii, 185.]

The Mississippi Jetties.—The military commission on the work of Eads for the improvement of the south pass of the Mississippi River say that an enlargement of section and an application of stone are essential to the security of the jetties, and that the enlargement at the sea ends, and consolidation throughout by the application of stone, should be undertaken at once, and a reasonable progress thereon be made the condition of the second and all future payments. [*Chicago Railway Rev.* xiii, 187.]

MINING, METALLURGY AND MINERALOGY.

Newfoundland Copper Deposits.—Exciting accounts continue to arrive from the mining region. At Tilt Cove a second discovery, believed to be of enormous value, has lately been made. About three-quarters of a mile from the present mine a large mass of copper ore has been found, the deposit being in beds, and can be traced for a considerable distance. Professor Hind, who happened to be present when it was discovered, pronounces it of great value. At Bett's Cove they are working a bed of copper ore 40 feet in thickness. They have nearly completed the export of 20,000 tons of ore this year. It is but two years since the mine was opened, and in that time 26,000 tons of ore have been exported. The north side of the Gander Lake and over a considerable area northeast from thence, rocks of the serpentine group, having most of the characteristics of the copper-bearing formation in Notre Dame Bay, are extensively developed; while, again, on the Main Gander River they occupy an immense area. It is only reasonable to suppose that the ores of copper and nickel will at some future time be found to exist here also. Until the country is opened up and settled it is not likely such mineral deposits will be found, or could be worked with success, even if discovered. Such, then, is this fine Gander country (recently discovered), in which there is not yet a solitary settler or lumberer, and which is only visited by a few trappers. Gander River is approached from the sea at Sir Charles Hamilton's Sound by the great inlet of Gander Bay, the head of which in latitude 49° 17′ N., and longitude 54° 29′ W. From this point to the lake the river is 30 miles in length. Crossing the lake, the main river was followed for a distance of 60 miles, to within a day's journey of Bay D'Espoir. Beyond this point the river is split up into numerous small brooks, which take their rise in the surrounding hills and marshes. The total length of the Gander River is thus about 100 miles. [From correspondence in *Toronto Globe* of Nov. 18.]

—M. E. Audouin proposes the use of oxide of chromium as a refractory lining for furnaces wherein very high temperatures are employed. Although oxide of chromium itself is at present a rare substance and of high price, yet the raw material rich in chromium—chrome ore—is found in abundance, and in a great number of cases the impure oxide of chromium allied with oxide of iron as found in the ore, using only that containing at least 45 or 50 per cent. of oxide of chromium, may be employed. This material, as well as the oxide of chromium itself, may be employed in blocks, or other moulded forms, by pulverizing the material to the desired degree of coarseness, compressing it, and then burning it if necessary. The material may be employed either alone or combined with a small per percentage of agglomerating substances, such as aluminous or other earths, alumina or silicate of alumina and others. Oxide of chromium may also be employed with advantage for making any vessel in which metal in fusion is to be contained, such as ingot and other moulds, as a substitute for the more or less silicious matters usually employed, which combine with the metal at high temperatures, and in lieu of

cast-iron moulds, which are expensive, and last but a short time. [*The Engineer*, xlii, 343.]

Phosphor-Bronze and its Uses.—The superior endurance of this new alloy is bringing it rapidly into use for many other purposes besides those for which it was first employed. It still continues in demand for bearings or bushes, but is being widely adopted with great advantage for pit ropes, telegraph wires, bolts, &c. When used for telegraphic purposes it is said to have thrice the conductivity as well as strength of the iron wire commonly used. Power of endurance is also shown in its usual application to bearings, where the phosphor-bronze has been found to wear nearly five times longer than gun metal, besides being less liable to heat. Even when heated it does not cut the journals. The railway companies, both in England and on the continent, have found this out, and are largely applying it in the construction of the bearings of the carriages, which have to travel long distances without stopping. The gain in respect of economy is also great, showing a saving of four to one in favor of the phosphor-bronze. The bearings of rolling mill engines have to endure a similar amount of friction, and some of the largest concerns of that description in England have adopted it with the most satisfactory results.

Excellent results have also followed the use of phosphor-bronze for plungers, pump cylinders, and piston packing. Its advantages for the latter are to be found in its remaining unacted upon by the corrosive liquids usually found in mines; and when manufactured into wire cables and ropes it is found not liable to take a crystalline structure under the action of repeated shocks, which is the case with iron and steel, as many serious and fatal casualties testify. While it is very hard, it does not emit sparks when struck upon a harder surface, and is thus very suitable for the tools used in the gunpowder manufacture or for miners' pickers.

Some fine ornamental castings in phosphor-bronze, as well as some specimens of bearings, &c., were exhibited at Philadelphia, and the Phosphor-bronze Company obtained a prize at that exhibition for the excellence of these and other of their products there exhibited. A metal which can be made more ductile than copper, at thugh as wrought-iron, and as hard as steel, is necessarily fitted for many uses, especially as it can be remelted without any material loss or alteration in vuality. [Abridged from *Iron*.]

CHEMISTRY, PHYSICS AND TECHNOLOGY.

*The Radiometer** or "light mill" is claimed by Delsaulx (of Belgium) to be an electrical engine. Frankland, using moonlight (which is practically devoid of heating power) claims that light is not necessary to the operation of the instrument, and that heat alone will and does rotate the apparatus.

Physical Culture.—Dr. Bourcq shows that gymnastic exercises increase the muscular forces 25 to 38 per cent-, and equilibrate them in the two sides of the body; increase the pulmonary capacity, and the weight up to 15 per cent., while reducing the bulk. M. Paz confirms these conclusions by means of a distinct course of investigation.

Spectra of the Planets.—Some researches by M. Vogel on the spectra of planets, undertaken in view of a prize question proposed by the Copenhagen Academy in 1873, which gained the prize, have been published in *Poggendorff's Annalen*. The following is a short *résumé* of them. The spectroscope shows the light of the planets to be in general reflected solar light. The principal Fraunhofer lines are found in the light of the brightest. The idea of a light proper to Jupiter and Saturn, as explaining their peculiar whiteness, seems unfounded; for the presence in the spectra of these planets of lines and bands of absorption, identical with those produced by our atmosphere, seems to prove the existence of aqueous vapors in the gaseous envelopes of these planets, and it is difficult to suppose the temperature of their surface high enough to cause an emission of light. The solar and the planetary spectra differ in that the latter have absorption bands, more or less intense, in the less refrangible parts; and these may be attributed to the atmospheres of the planets. The further the star is from the sun, the more preponderating is the influence of this atmosphere. The interior planets, Mercury and Venus, have only very weak absorption bands in the red and yellow, which are coincident with lines produced by passage of light through our atmosphere. Mars presents the same bands, but more marked. In the spectra of Jupiter and Saturn, there is, besides these bands, a very intense band in the red, and all the more refrangible part (violet and blue) is greatly weakened, without bands being distinguishable. Lastly, the spectra of Uranus and Neptune are crossed everywhere with broad and intense absorption bands. [*Eng. Mech.* xxiv, 288.]

*Described and profusely illustrated in our Vol. ii, No. 1, *et seq.*

A Lightning Rod Tester was recently illustrated in *Dingler's*; and consists of a galvanic element, a galvanometer, and sufficient insulated copper wire to make the requisite earth and other connections.

MISCELLANEOUS.

The Indian Cyclone.—Further details received regarding the cyclone of October 31, prove it to have been one of the most terrible calamities on record. Estimates based on official returns from each police section put the loss of life in the districts of Backergunge, Noakholly, and Chitagong at not less than 215,000. Three large islands—Dakhin, Shahabazpore, Hattiah, and Sundeep, and numerous small islands were entirely submerged by the storm wave, and also the mainland for some five or six miles inland. These islands are all situated in or near the estuary of the Meghna, a river formed by the confluence of the Ganges and Brahmapootra rivers. Up to 11 P. M on the night of the catastrophe, there were no signs of danger, but before midnight the storm wave swept over the islands to a depth in places of 20 feet, surprising the people in their beds. The country is perfectly flat, and, therefore, trees were the only secure range. Almost every one perished who failed in reaching trees. A strange fact about the disaster is that in Dakhin Shahabazpore and Hattiah most of the damage was done by the storm wave from the north sweeping down the Meghna. Several theories, the *Times* Calcutta correspondent states, have been started to account for this. One is that the cyclone, forming in the bay, struck the shore first near Chittagong, and went north for some distance, and then turned southward again. Another is that the wind blew back the waters of the Meghna, which rebounded with terrific force when the pressure relaxed. A third supposition is that there were two parallel storms with a centre of calm between them. The first or third theory seems most probable, as in Sundeep and Chittagong the destruction came from the south. [*Nature*, xv, 89.]

Salting the Streets in Winter.—Looking out well a-head, as their countrymen generally get credit for doing, the members of the Glasgow Police Board had this slovenly and dangerous practice under discussion a few days ago. The gentleman who brought the subject before the meeting showed that there had been a considerable increase in deaths from lung disease in the city in 1875 over the previous year, and said that there was medical testimony to the fact that these and other deaths were distinctly traceable to the saturation of foot-passengers' boots in the morning wiih the frozen brine, which kept the feet damp and cold the whole of the subsequent day. It is well to remember that besides the intense coldness of the mixture—5° below zero, or 37° of frost—snow-brine does not dry up as speedily as water alone would; and after several saturations in the mixture, boots never become thoroughly dry afterwards. The salting of streets is equally productive of injury to horses. It was stated by the speaker that during last winter three of the largest horse proprietors in Glasgow had laid up, from this cause alone, in one case fifteen, in another forty, and in a third no fewer than 100 horses, the ailments of those animals having been produced by their wading through the snow and salt that had been mixed on the streets. This, we believe, was not a rare experience with the proprietors of horses in London last year, although salt appears to have been scattered about with a less lavish hand in London than in Glasgow. What the authorities empowered the omnibus companies to do, was in both cities also practiced without permission by the tradesmen, in order to dissolve the snow on the foot-paths, while at the same time they frequently neglected to remove the sludge. The Glasgow board has remitted the matter to the magistrates, who are the proper parties to deal with it, and, from what passed at the meeting, it is probable they will do so effectually; and set an example which the metropolitan authorities will do well to follow. Of the exceedingly baneful effect of the practice there can be no doubt, and the population of London are perhaps still worse prepared to resist the effects of these freezing foot-paths than those of Glasgow. [*Technologist*, vii, 248.]

The Permanent Exhibition promises to be a grand success, the applications for room being already so numerous as to more than fill the Main Building, and that fact will give our readers an idea of what the exhibition will be. Many foreigners have applied for space, and it is believed that nearly all the countries represented at the Centennial Exposition will secure room in the Permanent Exhibition for the display of their goods. Those articles exhibited during the summer and fall will generally be removed, to be replaced by other and still better ones, fresh from the manufacturers and artists of this and the old world. The manager has received such an immense number of applications that he will be compelled to make selections from the mass of articles submitted, and by so doing those accepted will be of the best quality, and in numerous instances superior to those of the same character displayed at the recent Exposition. The directors design to improve the conveniences of the Main Building in every possible manner, especially in widening the passages and avenues, and introducing such other changes as may be deemed necessary to facilitate the movements of large crowds and give visitors better opportunities to view the exhibits. The success of the Permanent Exhibition is assured beyond a doubt, and we have no fears but it will be conducted in such an enterprising and liberal spirit as to merit the support and well-wishes not only of Philadelphia, but of the country. [*North American.*]

EDITORIAL CORRESPONDENCE.

HARMONIC TELEGRAPHY.

Messrs. EDITORS:—An article on the electrical exhibit of the U. S. which appeared in the supplement to the *Public Ledger*, November 18, reminds me of a description of Mr. Elisha Gray's harmonic telegraph in the POLYTECHNIC REVIEW of the current volume, and makes me think that it might interest you to learn that I can claim the priority of invention for a countryman of mine, Mr. Paul La Cour, assistant director of telegraphs in Denmark.

Mr. La Cour presented a memoir to the Royal Danish Academy of Sciences which was read the 12th of February, 1875, and of which a pretty full abstract is to be found in the *Annales de Chimie et de Physique*, 1875, June, p. 284. In this memoir he states that he made the discovery May 10, 1874, and his first experiment June 7, 1874. The night between Nov. 14 and 15, 1874, he demonstrated its practicability on the line Copenhagen–Fredericia, a distance of 390 kilometres.

His discovery is based on the fact that when a tuning-fork, by its vibrations, closes and opens a circuit, it will make a tuning-fork at the other end of the electric wire vibrate *only* when both are tuned alike (in unison). He claims the following advantages:—

1. That of a number of tuning-forks, only the one in unison will respond and not the other ones.
2. Messages may be sent between two stations without the intermediate stations being aware of their nature.
3. Several messages may be sent by one and the same single wire at one and the same time.
4. Several messages may be sent to different stations by the same single wire and at one and the same time.
5. The tuning-forks are not affected by ordinary extraneous electric currents, unless of high intensity.
6. This system may be used in pan-telegraphy quicker and more reliable than those of Bain, Casselli, and others.

Mr. La Cour's apparatus consists of a tuning fork fixed by its stem, and a "contact" so arranged that one of the branches of the fork touches it in each vibration. The stem of the fork is connected with one pole of a voltaic battery (pile). The receiving apparatus consists of a tuning-fork of soft iron (of the same pitch), fixed by the stem, and the branches of which pass freely through the axes of two wire bobbins. An electro magnet is placed so that its poles are opposite to the opposite poles of the tuning-fork. The intermittent current will pass through the wire bobbins and from thence to the wires of the electro-magnets; the tuning-fork will vibrate and touch the "contact," which communicates with the local apparatus.

As you will see, Messrs. Editors, I do not in the least try to invalidate Mr. Gray's claim to *originality*—the *priority* of the idea of using tuning-forks (or their equivalents) in telegraphy, undoubtedly belongs to Mr. La Cour.

Very respectfully yours,

HANS M. WILDER.

Philadelphia, Dec. 6, 1876.

BIBLIOGRAPHICAL NOTICE.

Chemia Coartata; or the Key to Modern Chemistry. By A. H Kollmyer, A. M., M. D.; 114 pp., 8 mo. Philadelphia, Lindsay & Blakiston.

This work is a hand-book of chemistry, embracing the reorganic and organic divisions of the science, and designed as a book of reference for students and amateurs. The arrangement of the work is tabular, and the author has succeeded in condensing into its small compass, the leading facts concerning the elements and their more important combinations. The tables give for each substance its synonym, history, how obtained, the reactions involved, its more important physical and chemical properties, and its distinguishing tests. The tables are preceded by a few pages of condensed explanatory matter, defining the terms and phraseology of the modern chemistry.

The field attempted to be covered by the author is so vast that we are not tempted to criticise faults of omission, since he has succeeded in affording the student a most useful compendium of information in extremely convenient form for reference.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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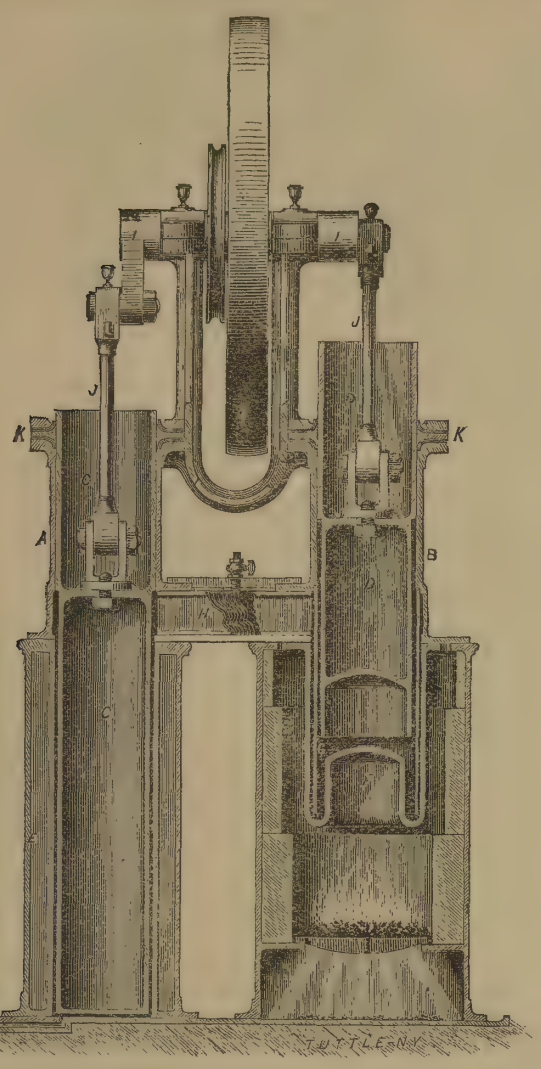


THE RIDER COMPRESSION ENGINE.

As its name implies, the chief and distinguishing feature of this Engine is the use of highly compressed cold air, the heating thereof without change of volume, and its expansion to a point to or below the pressure of the atmosphere, the aim being to completely utilize all the force or mechanical effect possible.

As may be seen by the sectional cut, the Rider Compression Engine consists essentially of a compression cylinder, A, and a power cylinder, B, with their respective pistons, C D, and connections, and a regenerator H.

The lower portion of the compression cylinder, A, is kept cold by a current of water which circulates through the cooler, E, which surrounds the lower portion of the cylinder, while the lower portion of the power cylinder is kept hot by the action of the fire below the heater, F.

The heating, and also the cooling of the air, is effected by its alternate presentation to the surfaces of the heater and cooler, in a thin annular sheet, such being found by experience to be an excellent method of rapidly and thoroughly effecting changes of temperature in air.

This is accomplished as follows :—

The compression piston, C, extends downwards to the base of the Engine, and is a trifle smaller than the interior of the cooler, E, thus leaving a thin space on all sides for the air to pass downward and become cooled on its way to the bottom, and through which space it flows on its way back to the heater.

The power piston, D, likewise extends downwards into the heater, F, which in shape resembles the bottom of a champagne bottle, that is, rising in the centre, and presenting to the action of the fire a narrow annulus all around the bottom. Within this heater is the telescope, G, which is a thin iron cylinder, about one-fourth of an inch less in diameter than the interior of the heater. It is fitted to the interior of the power cylinder, B, and extends nearly to the bottom of the heater. Its office is to cause the air which flows from the compression cylinder to be presented in a thin sheet all around the interior surface of the heater, and particularly at the lower and hotter portion. By this means the air is thoroughly and rapidly heated.

The same air is used continuously, and there is neither influx nor escape, the air being merely shifted from one cylinder to the other.

Between the compression and power cylinders is situated the regenerator, H, which performs a very important function. It is composed of a number of thin plates slightly thickened at their edges, which, while affording a free passage to the air, subdivides it into thin sheets. It is so placed between the cylinders as to be traversed by ths air in its passage each way between the hot and cold cylinders. Thus the heat is alternately abstracted from and returned to the air in its passage backwards and forwards through these plates, imparting economy and steadiness of power to the engine.

The other portions of the engine are readily understood on inspection of the cut. The two pistons are attached directly to the crank, I I, (which stand at an angle of about 95 degrees from each other, the crank of the power piston being in advance), by connecting rods, J J. All the movements of the various parts are uniform, being derived from regular, circular and rectilinear motion; there are no complicated parts, and none of the irregular intermittent impulses whichcharacterize caloric engines. A high rate of speed and smooth action may be safely and easily obtained.

K K are the packings, which are in duplicate for each cylinder. The lower one has its lap downwards, to resist the escape of air below the piston, while the upper one has its lap upwards to prevent the lubricating material from entering too freely into the cylinders.

Between them is the relief ring, which is constructed with the intention of greatly relieving the friction of the packings.

L is a check valve which supplies any leakage of air which may occur. It is generally placed at the back of the engine, at the lower part of the compression cylinder, but is necessarily shown, in the sectional cut, on the side.

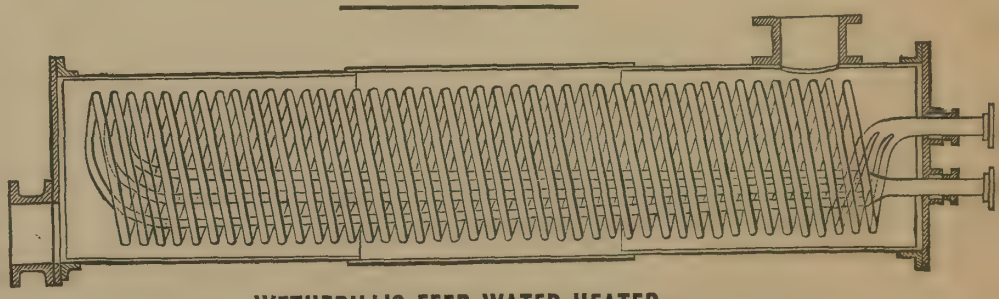
The operation of the engine is briefly as follows :—

The compression piston, C, first compresses the cold air in the lower part of the compression cylinder, A, into about one-third its normal volume, when, by the advancing, or upward motion of the power piston, D, and the completion of the down-stroke of the compression piston, C, the air is transferred from the compression cylinder, A, through the regenerator, H, and into the heater, F, without appreciable change of volume. The result is a great increase of pressure, corresponding to the increase of temperature, and this impels the power piston up to the end of its stroke. The pressure still remaining in the power cylinder and re-acting on the compression piston, C, forces the latter upward till it reaches nearly to the top of its stroke, when, by the cooling of the charge of air, the pressure falls to its minimum, the power piston descends, and the compression again begins. In the meantime the heated air, in passing through the regenerator, has left the greater portion of its heat in the regenerator plates, to be reäbsorbed and utilized on the return of the air towards the heater.

The packings are discs of leather; those on the hot cylinder are cooled by a small stream of water, which circulates round the upper portion of the cylinder.

The connecting rods have their ends, of gun-metal, connected by a tube, in which is fitted a rod, extending from the upper to the lower brass, and so arranged that one key, capable of adjustment by nuts, takes up the lost motion on both upper and lower brasses. This tube also permits the oil to flow down to the lower brass, and thus *both ends* are lubricating from the oil cup at the same time. It will be seen that this construction is at once efficient and durable; no loose straps, gibs, or other pieces are used, and there should be very slight chance of consequent breakage.

As before stated, in the pumping engines the whole of the water pumped is passed directly from the pump through the cooler, thus effectually and instantaneously cooling the heated air, which passes down the interior of the cooler on its way to the bottom. A very small pump is furnished with the power engines, which is attached like the large pump of the pumping engine, to the side of the cooler, and a small stream of water is injected with each stroke of the piston, This may be returned, if desired, to the barrel or reservoir whence it is taken, until the water becomes in time too warm for effective use; or, it may be allowed to run to waste, which is preferable where water is not too scarce, as the cooler the compression cylinder is kept the better. Where a pressure of water can be obtained, the small pump may be disconnected if desirable, and a very small stream allowed to flow into the cooler and pass out at the opposite side.



WETHERILL'S FEED WATER HEATER.

This consists of a wrought iron cylinder riveted to cast iron rings, and closed at the ends by cast iron bonnets, the latter being easily removed. The feed water is heated by passing it through numerous coils of copper pipes, one inch in diameter, (surrounded by the exhaust steam from the engine,) dividing it up into small bodies and causing it to reach the boiler at a temperature, as claimed by the manufacturer, of 212° F. It is almost as valuable when applied to condensing as to non-condensing engines. In the former case, the exhaust steam passes through the heater, on its way to the condenser, thereby heating the feed water to 212° F., and reducing the work on

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DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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NOTICE—Our special number with Professor R. H. Thurston's article on Lubrication, will not appear until the first or second week of the coming year, owing to important additions and alterations which are being made to the article. [*Eds.*]

the air-pump by the amount of steam condensed in the heater. The coils are continuous, with no joints, and unite at the ends to form the inlet and outlet pipes. The superior elasticity of the copper pipes enables them to expand and contract without liability to fracture; their greater conducting power makes the heating surface much more efficient, and the absence of corrosion renders the heater, practically indestructible.

The makers are Robert Wetherill & Co., Chester, Pa.

FIRE ESCAPES.

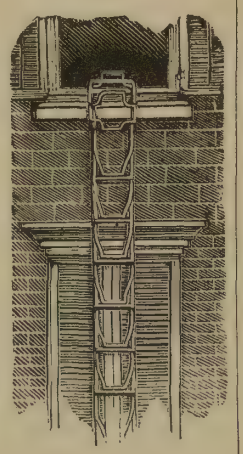
II.

The Novelty Portable Fire Escape, shown in Fig. 1, is intended for factories, more especially. It consists of a swing ladder with hickory rounds and wrought iron links; between each pair of rounds is a light frame of iron which keeps the ladder out from the building. A hook on the upper end sustains the whole when in use. It can be folded into a very small parcel (14x16x24 inches high), and weighs about one pound to the foot. It is approved and recommended by the Department of Buildings of New York City.

1—FORT-FOOT FIRE-ESCAPE, FOLDED UP.

2—CLOSED.

3—OPENED.



4—OUTSIDE VIEW.

A modification of this device, for household use, is shown in Figs. 2, 3 and 4, giving views of the apparatus as enclosed in a table, (Fig. 2); opened and ready to be thrown out, the box forming an additional brace against the window, (Fig. 3), and as seen from the outside, fastened on the inside of the window-sill ready for use (Fig. 4). The apparatus is made by Louis Falk, Morrisania, N.Y., and was shown in Machinery Hall.

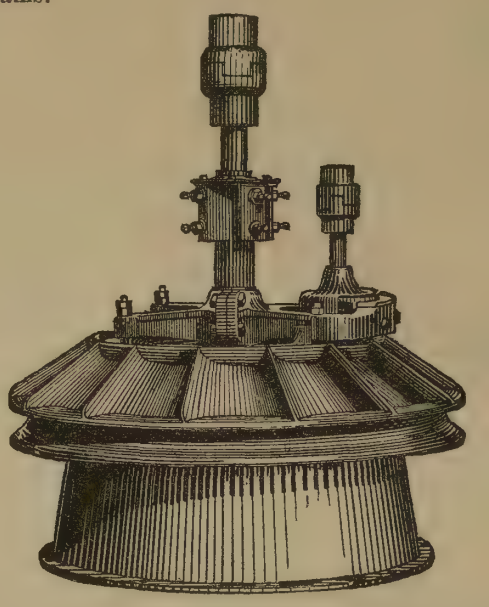
TURBINE WHEELS AT THE CENTENNIAL EXHIBITION.

V.

THE HOUSTON TURBINE.

A striking feature of this turbine is its compactness and simplicity; consisting essentially of three parts, viz: the gates, the guides, and the wheel; each in one piece of cast iron. These parts are conical in form, like the crown of a bevel gear wheel, to which fact the compactness of the turbine is chiefly due. They lie one within the other, as shown by the accompanying cut, which indicates the lines of separation. The gate is placed uppermost, with stationary guides between it and the wheel.

The gate is of the form known as the "register gate," consisting of a ring with ports cut through, and corresponding with chutes in the stationary guide ring. The gate openings aid those in the guide ring to form the complete chutes. When fully open, the chutes appear of very good form; but the offsets formed in partial gates must tend to form vacuous spaces, the effect of which would be to exert an unfavorable influence on the streams.



The gate ring is carried on a spider, which has a central bearing on the wheel case. The ring is adjustable in height by means of serews and nuts, so that the ring can be made to swing just clear of the guides, and free from friction. The opening and closing is effected by the use of a segmental rack and pinion. The guide ring connects the wheel cover with the flange upon which the whole turbine is supported.

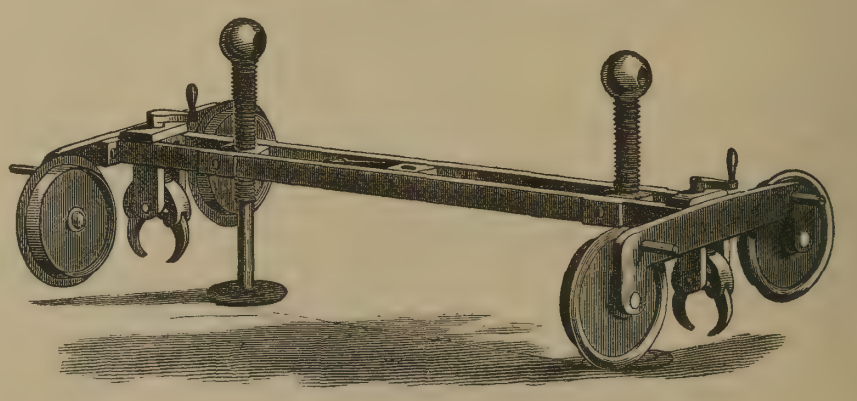
In cases where the power is likely to vary considerably, as in mills, the turbine must be sufficient for the greatest demand. But when a much less power is required for a considerable period at a time, port blocks may be applied to close up part of the chutes, so that the remaining ports will run nearly full. This is advantageous for the reason that full chutes are found to give higher percentages than fractional ones.

By giving the parts a bevel wheel form, the wheel of the turbine is enabled to receive the water and discharge it downward freely, without changing its direction much as regards the meridian section, as shown in the figure. The floats of the wheel are strongly inclined back, even at the first elements, thus considerably differing from the usual practice of making them normal to the wheel face. This is admissible, theoretically, provided the guides have a proper inclination; which in this case would require an angle of intersection with the wheel face of over 45°.

The wheel rests upon a step of lignumvitæ carried on the bridge-tree, the latter differing from the usual form by having attached, as shown in Fig. 4, a cup which holds water for lubricating the step. This prevents the step from becoming excessively dry when the wheel stands, for a time, above the water of the tail race. A draft-tube is attached when required, as shown in cut, which then carries the bridge-tree.

Experimental tests of various sizes of wheel in different localities, have given high percentage, which, as well as simplicity and compactness, speak well for the wheel. Manufactured by Fales, Jenks & Sons, Pawtucket, R. I.; Merrill & Houston Iron Works, Beloit, Wis., and W. P. Duncan & Co., Bellefonte, Penn.

ALDRED'S RAILROAD TRACK LIFTING MACHINE.

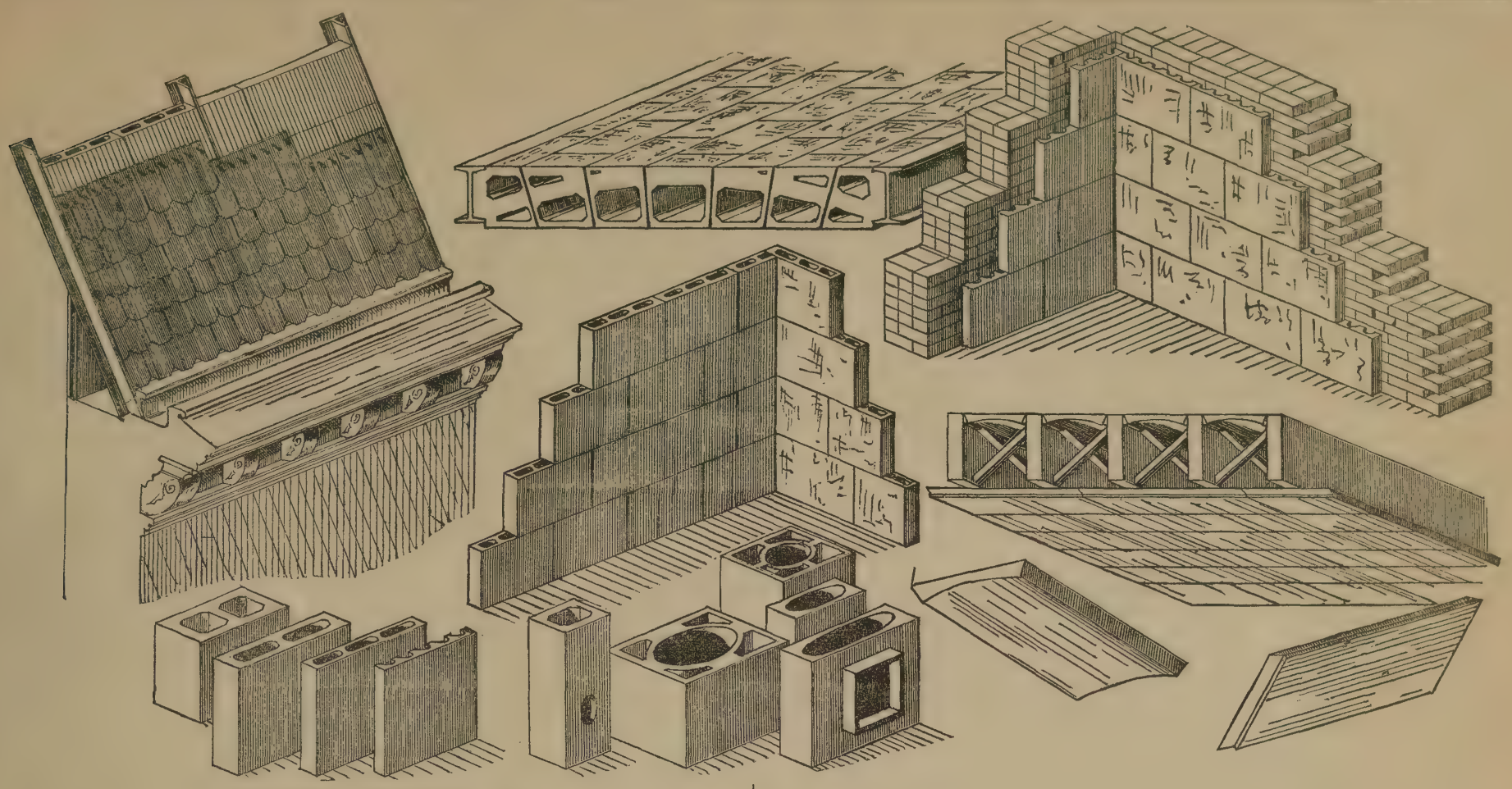


[CANADIAN SECTION, MACHINERY HALL.]

The device illustrated herewith is for the purpose of lifting railroad tracks for ballasting and leveling the line. The cut requires but little explanation. There is a truck frame with four ordinary flanged wheels running on the rails. The truck has a strong central cross-bar, bearing a spirit-level and scale, by which any degree of inclination is indicated. Through this central bar two powerful screws play in suitable swiveled nuts; and have each a pivoted base plate to thrust against the ground, and a suitable lever at the top.

Depending from the side bars of the truck are seen two clutches operated by a screw, so as to grip the rail to be raised or removed. The rail being clamped between the jaws of a clutch, the truck and rail are raised by means of the thrust-screw before mentioned; the level and scale indicating the degree of inclination when raising the rail for curves.

The machine is constructed of wrought iron, and weighs about 225 lbs. Its advantage over the hand lever is apparent. It is patented in this county and in Canada, by Mr. C. Aldred of Glencoe, Ontario, P. Q.



FIRE-PROOF CONSTRUCTION.

All who have thought much of the numerous and ever-recurring fires in American cities, and of the large conflagrations following each other with almost periodical precision, must see that the conditions favorable to the most terrific conflagration exist in every one of our large cities. Wherein is this or any other city better guarded against fire than Chicago or Boston were? Certainly not in a better method of building, a better supply of water, or in more fire-proof roofs!

The security mainly relied on is a superior firemen's organization. This though is exposed at almost any moment to serious demoralization and various disorganizing agencies, at work in the municipal machineries of most of our cities. Under adverse circumstances, even with thorough organization, the fire department avails but little.

It would not seem an incredible supposition, that a large part of any of the large centres of population could be destroyed in a day or two, through the possible coincidence of circumstances, such as a high wind, severe cold, short water supply, and the breaking out of a fire in some crowded wooden quarter.

The history of the terrible fires of Portland, Chicago, Boston, Chicago again, Baltimore, Virginia City, all of which occurred in one decade, shows the permanency of the danger and the possibility of a recurrenee of similar disasters.

After each new conflagration we hear a great deal about fire-proof construction, while volumes are written and authorities cited, to prove the futility of any attempt at opposing an efficient barrier to the devastating element. After a time, as usual, we subside in comparative indifference, until we are awakened once more by another gigantic catastrophe.

The penalty of our indifferenee is the destruction of from thirty to forty millions worth of property annually, exclusive of the wholesale destruction by the tremendous conflagrations referred to. The aggregate loss of property by fire during the decade 1866–1876 cannot fall short of one thousand million dollars—equal to one-third of the National Debt.

And what of the loss of human life, most recklessly sacrificed, often through neglect of the simplest preventives. None can have forgotten the heart-rending news of the roasting alive of seven poor working women in the cotton mills at Neponsel, Mass., in March, 1870, nor the fire at the Fifth Avenue Hotel, New York City, in the winter 1872–73, during which seven female servants lost their lives; nor the eighteen infirm men and women perishing in the flames at the "Home for the Aged" last March, at Brooklyn. And how much more impossible yet to forget the 283 lives that perished in the Brooklyn Theatre, simply because the construction was of the most fire-inviting character.

The amount of worry and anxiety caused by the apprehension of the danger, and both loss of property and eventual loss of life, should be sufficient to warrant a diligent search for safeguards against it,

Preventions are numerous and may be classed in three separate kinds. The first comprises the most elementary precautions, such as the safe keeping of matches, the protection of lights in stables, barns, factories, etc., the storage of combustibles at safe distances from fire-places and flues. The second consists of the various appliances, mechanical and chemical, to extinguish fires. The third and most efficient of all, consists in fire-proof construction.

The study of the latter should not be neglected on account of improvements accomplished in apparatus for extinguishing fires.

The question of the possibility of building fire-proof cities has been the subject of great controversies, and the conclusions reached have seldom been such as to encourage fire-proof constructions.

Some of the eminent architects of the day have been found among the most skeptical; yet to them it may be argued with much truth, that while there may always be found men in the world who say: "This can't be done," "That can be done," there have always come some other men who have done these same "impossibilities." When the Communists tried to burn Paris, they failed; not because the fires were put out by engines of any kind, but because the city was so built that it would not burn. What would be the fate of an American city under similar circumstances, is easily foretold.

We believe the explanation lies in the superior fire-proof structure of the European houses. The slate and tile roofs, cement or tile floorings, brick stair-cases, and brick or plaster filling between floor beams and rafters, are what protect each house and cause a fire, if it breaks out, to be of short duration and little expense; on the other hand we Americans build fire traps and look for protection from Insurance Companies and Fire Departments.

Let us derive benefit from the practical teachings of the conflagrations of the Parisian Commune, and regard them as a test of building materials, costly yet simple and complete.

The total destruction of some of the public buildings was due more to shot and shell than to fire. The larger part of the Hotel de Ville, and the whole of the Tuilleries excepting the "Pavillon de Flore," were provided with wooden floor beams and roof frames, unprotected by the improved modern devices. While those portions of the latter and many others of more recent erection, were provided with iron girders and roof frames, filled in with brick or plaster of Paris. The combustible parts in these buildings, furniture, flooring, doors, etc., were consumed, while the constructive parts remained uninjured. Not in one single instance did an incendiary fire extend beyond the premises in which it was started.

The qualities of materials commonly used in building, in relation to heat, may be classed in three divisions. 1st. Those which are combustible but non-conductive, in which class must be placed timber. 2d. Those which are not combustible but are ready conductors of heat, and in the presence of heat lose all strength and utility as building materials; in this class are the metals used in construction. 3d. Those substances which are not combustible, are bad conductors of heat, and do not lose their cohesive strength under the influence of heat. In this class are comprised stones, earths and cements. This last class, however, must again be separated into two subdivisions, as there are some stones which are chemically affected by heat, notably the lime and magnesian carbonates; indeed the great majority of stones are affected by strong heat. Foremost among the stones or cements that best resist the action of fire and are bad conductors of heat, stands Gypsum, better known as "plaster of Paris." This is the one cement that has proven, under the very trying circumstances created by the Communist incendiaries, to have been an absolute protection to materials, which otherwise would have been destroyed.

Lime stone, *per contra*, when deprived, by calcination, of the carbonic acid, becomes a body which may be crushed by the slightest pressure, or if treated with water assumes double its original bulk and falls to powder. A concrete composed of the ordinary lime or lime cement, in as much as it approximates, when set, to the original carbonate, would of course, manifest the same characteristics under similar treatment.

The use of iron in house building, when unprotected by a fire proof material, is dangerous in the highest degree; it should therefore only be used in building as the bones are used in the human body, to give strength, and should then be protected by some material as the bones are by the flesh and muscles. The danger in the use of iron is mainly where it is relied upon as a *sole* dependance. Wooden beams, under certain conditions, have proved more lasting than iron improperly protected. It is far from our mind to revert back to the use of the massive vaults and ponderous piers of bygone days, but would insist that both wood and iron, as building materials, should be used in accordance with the teachings of science and facts of the day. Owing to the comparative costliness of iron, and the abundance and moderate cost of timber, we assume that the latter will, for a very long period, be used generally for beams, rafters and girders, while iron will only be exceptionally used for the same purposes. In either case it is essential that the constructive parts should be protected with a non-combustible and non-conductive material applied in a rational manner.

Wood lath must be entirely discarded, while sheet iron in any shape, if used at all, should be so only with the utmost caution and never without effective protection.

A material possessing all the qualities requisite to supplement the deficiencies of both timber and iron, is coming into use, which it is to be hoped will ere long be universally employed in the buildings of large cities, even if not required by law; we refer to the fire-proof hollow blocks for arches, partition walls, roof filling, etc., invented and patented by Mr. A. Wanner of New York City, a good idea of which can be gained from the accompanying illustration.

The object of this invention is to restrict the use of timber in the building of houses to

a minimum, and in some cases to exclude it *in toto*, for instance in partition walls, in floors where iron girders are being used and in Mansard roofs, by filling between light iron rafters. Its further purpose is in buildings where timber is being used or in houses already built, to supersede lathing, furring and pugging by a light, but hard, homogeneous, non-combustible body.

Unlike the concrete used for foundations, or artificial stone, in the composition of which limestone cements and broken limestones enter to a large extent, the action of which under fire is well known, this superior description of concrete, which forms the fire proof medium in Wanner's construction, is chiefly composed of coal ashes or cinders, and "plaster of Paris" as a cement. This body, as has been shown by numerous public experiments, loses none of its cohesion under fire, remains intact though subjected to a great heat, while the application of water while in that state, does not materially impair its strength.

This compound, a non-conductor, remarkably light and very tough, cannot be excelled as a sure protection of the iron used in construction, such as columns, girders and rafters. The various forms in which it is moulded, honeycombed by a series of tubes or flues and the numerous purposes for which it is adapted, render it most valuable in construction of every description, from the largest public building down to the artisan's cottage.

The presence of flues in partition walls and ceilings which may be easily connected, furnish convenient and safe ventilating or smoke passages.

The difference in weight between Wanner's concrete and brickwork is from 55 to 60 per cent. in favor of the former. Architects will see that by the use of Wanner's arches in lieu of brick, the reduction in dead weight affords the means of a proportinate reduction in the weight of iron, leaving the assumed carrying power the same.

The following informatiom regarding the weight of this material may be of benefit to architects and builders:

One cubic foot of the solid material weighs 55 lbs.

One square foot, one inch thick, 4½ lbs.

The hollow spaces represent about 2-5ths of the whole mass, therefore,

One square foot of 4″ partition wall weighs 2-5ths of ⅓ of 55lbs = 11lbs.

One square foot of 8″ arch weighs 2-5ths of ⅔ of 55lbs = 22lbs.

This valuable material excels all others for the construction of light fire-proof partition walls; floor arches; Mansard and deck roofs; lining over brick and stone walls as a substitute to furring aud lath; ceilings under wooden beams, as a substitute to lath; deafening between floors and roof beams instead of sound-boards and mortar pugging or sheathing; and ventilating, hot air and smoke flues.

In a partition wall of Wanner's construction, the ribs between the tubes represent and act as studs ¾ to 2 inches thick, spaced from six to ten inches to centres; the wall faces replace the lath and plaster. These walls, when built, require but one coat of fine sand stuff or hard finish.

When used for cottage walls, no outside finish is wanted beyond pointing or striking the joints, the appearance being that of a cut stone wall. These walls exclude sound, cold and heat; the material, being remarkably tough, holds nails and screws with nearly as much tenacity as wood; thus no difficulty is experienced for the fastening of base boards, wainscoting or other trimming. The cost of these walls exceeds that of the common stud partitions by from 5 to 10 per cent.

Their thickness varies as per requirements, viz:

3″ is a proper thickness for closet or other short walls.

4″ replaces to advantage the 6-inch stud partition.

6″ is the thickness for hall walls and others intended to carry weight.

8″, 10″ and 12″ are the thicknesses for one or two story cottage walls.

This floor arching being provided with level ceiling and floor surface, containing internally a segmental arch structure, is recommended as a superior substitute for brick, sheet iron or any other material.

The tile or cement flooring is laid directly upon the fire-proof body, and so are the light wooden sleepers where a wood flooring is being used. Furrings and lath and plaster are dispensed with. The ceiling line is brought about one inch below the bottom flange of the girders, which are thus entirely *imbedded within the fire-proof body*, and practically safe from heat and consequent expansion.

The internal tubes and flues below and above the segment of the arch, afford easy means for ventilation and the conveyance of hot air to any desired spot; they will also be found convenient for the housing of water, gas and steam pipes and acoustic tubes.

The difference in weight between these and brick arches, or sheet iron with concrete on , is from 25 to 40 pounds per square foot, and affords consequently a saving of iron from 20 to 30 per cent., which is effected by increasing the spaces between girders from one to two feet without any diminution in the strength of the floor. One coat of fine sand stuff or hard finish is all that is required on the ceiling.

This form of arch is available for spaces of two feet up to sixteen feet; for large spans, strong abutments or tie rods are required.

The price of these arches compare favorably with brick arches devoid of ceiling, and appears to be lower than that of sheet-iron laid over with concrete.

The Mansard roof, so dreaded by Insurance Companies and owners of surrounding property as a standing menace, but too well justified by past experience, can be made perfectly safe from fire, both from within and without, as safe in fact as the best brick wall, by the use of light iron rafters and fire-proof hollow blocks as a filling between; the construction being similar to that of arches, and the rafters being entirely enclosed within the fire-proof body.

Slate or tile are laid on the outside in a slush of mortar and made fast with nails in the usual manner, while the inside is ready for the finishing coat. The roof treated in this manner will exclude heat and cold; its cost does not exceed more than eight or ten per cent. that of ordinary sheathing, lath and plaster.

Mr. Wanner has devised and adapted a fire-proof ceiling to wooden floor beams, which dispenses with all extraneous wood-work, as well as the interminable repairs caused by the warping and shrinking of the lath. This ceiling is made up in sections of about three square feet and 1¼-inch thick, connected with overlapping edges. These sections are secured by iron hooks to the beams; a space of one inch between the lower edge of the beams and the ceiling is provided to prevent breaks in the joints through heavy jars or deflections. One coat of plaster will finish it. This superior description of ceiling costs no more than a *good class* of three coat work on lath and furring strip.

The protection is made perfect by the use of Wanner's deafening slab. This slab with bevel edges is fitted between the beams flush on top, and made to rest on skewbacks fastened to the sides of the beams. This method of deafening not only deadens sound, but forms the very best foundation for tile or cement flooring. When used on flat roofs, no sheathing is required; tin, felt and gravel may be laid on in the usual manner.

Architects will readily realize the superiority of this to pugging over the sound board, as the dampness is mostly absorbed by the wood which it causes to warp. Its cost does not exceed that of the old method.

The lining over exposed brick walls with Wanner's corrugated furring slabs commend themselves to the attention of architects and builders as a happy substitute to lath and furring strips; the latter aside from being one of the best means of communicating fire from one floor to the other, are usually infested by vermin, and always liable to early decay.

This furring, imperishable in its nature, with a substantial inner face of one inch of solid material, strengthened by a series of ribs, between which ample air spaces are provided, forms at once an effective protection against dampness, and remains remarkably free of all cracks and rends so generally attending the use of lath and plaster. One single coat of plastering will finish it. The cost exceeds by from ten to fifteen per cent. that of the old method.

But it is in the shape of flues that Wanner's material shows its true excellence as a preventive of fires. It is a known fact that eight-tenths of all fires are traced to defective brick flues and overheated sheet-metal pipes. A single brick flue crossing a floor twelve inches deep, requires thirty bricks, equal to thirty-two feet of layers and joints, affording not only a possible but a probable chance for fire; not to mention a defective draught caused by the protuding mortar or the cavities left by imperfectly filled joints, subjecting the smoke in its ascent to such friction and continuous revolutions, that in most cases it has time to cool and condense before it reaches the top, resulting in the deposit of soot and smoky rooms.

A remedy lies in the use of the flues formed by this construction, they having a smooth bore and being made in sections of two feet long; there need be no joint in the crossing of floors or roofs.

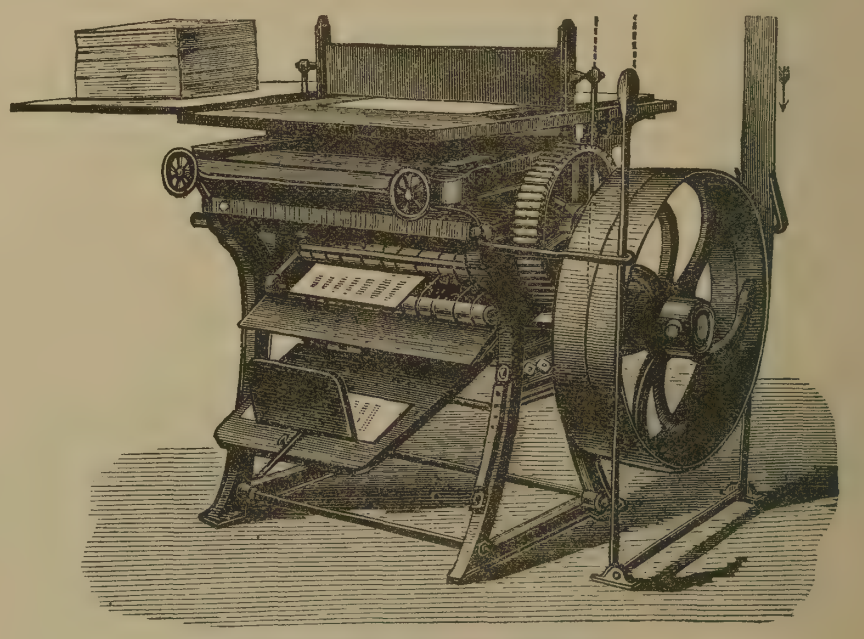
Besides, the material is a non-conductor of heat; there is no danger from their proximity to wood-work. As hot air or ventilating flues they are superior to tin equal to terra-cotta, and compare favorably with the latter as to cost.

All these precautions against fire are also useful, as they make a home more comfortable—excluding excessive heat and cold and deadening sound. The saving in insurance is also considerable, and should not be overlooked.

It is held to be a good maxim in war to do what your enemy least wishes you to do. The fire fiend craves light and exposed wood-work, loosely arranged and full of draught channels; therefore make him work for every inch of wood devoured; check and cramp him in close quarters; then a little presence of mind will corner and destroy him.

H. C. H.

THE FRANKLIN INSTITUTE CLASS IN PHONOGRAPHY is successful beyond all expectation, numbering over 100 members. There are three sections reciting at hours which should suit those of almost every avocation. The drawing schools are doing well; and we hope to record a large attendance at Mr. HUGO BILGRAM'S classes in "Link and Valve Motion." We would suggest that a series of illustrated lectures on, or classes in, Practical Mechanism would be quite within the scope of the Institute.



BLANK WORK FOLDING MACHINE.

MADE BY WILLIAM BRAIDWOOD, NEW YORK..

This machine is specially intended for use in folding blank work in sections, quires, or single sheets. It can also be used to very great advantage in folding ream paper and many kinds of job work, such as pass books, memorandum books, etc. In folding memorandum books or other small work, the paper can be folded in sections in its full length, and afterward cut in book form, materially reducing the time required in folding.

Paper can be thus folded much more accurately than by hand, and, after being folded, will present a much neater appearance; and in blank work the inside sheets of the section will be forced back closer than by hand, thus allowing the thread to lie closer in the fold, and preventing the end-way motion so frequently observed in the inside sheets of sections of blank books folded by hand.

All work suitable to the machine should be done more accurately and with greater rapidity than by hand.

"Popularity," in a scientific journal, is all very well in its way; but when that popularity is attained or maintained at a sacrifice of *reliability*, it is perhaps not so desirable.

PROGRESS IN SCIENCE AND THE ARTS

ENGINEERING—CIVIL, MECHANICAL, &c.

The Bessemer Swinging Saloon Steamer, which some time since created such a sensation among engineers, is about to appear in a new role. She has been re-arranged and fitted up with the view of adapting her to sea-going passenger traffic. A trial trip will shortly be made in the Humber.

A Chinese Telegraph.—Materials are now on their way out from England for the erection of a line of telegraph from the Imperial Torpedo College, at Tientsin, China, to the Viceroy's Yamen? The line, which will be about five miles in length, to be put up entirely by the students in the college. Once this line is up it is hoped to see telegraphs introduced by the Chinese Government, the great objection to their use having hitherto been that foreign engineers had to be employed both for their construction and maintenance. [*Jour. of the Telegraph*, ix, 373.]

Engineering Projects.—In the course of the Orientalists Congress at Marseilles, M. Lesseps (who has now arrived at Brussels, and is the guest of the King) mentioned that his son, in concert with some officers of the Russian staff, has gone to make the preparatory studies for a railway which should unite the Russian railway system with the English railways in India. He added that the Russian Emperor was warmly interested in this project. M. Lesseps also spoke on the project of flooding the Sahara, which he thinks a plan easily to be realized. It would improve rather than hurt the climate of Europe while it would fertilize North Africa, and would allow the French to extend their Algerian possessions beyond the southern mountains, which at present cost more to watch than they are worth. The Romans owed the solidity of their African empire to their military stations in these districts. But then, added M. Lesseps, they also occupied Tunis. From 1,200 observations made by M. Roudaire in Algeria aud Tunis it appears that there is a depression 27 to 41 metres below the level of the sea, and the only place where the tide in the Mediterranean rises as high as 2½ metres is where the bank would have to be cut to give access to the Sahara. The tide would thus aid the waters to flow in. The oases are all above the level of the sea. M. Lesseps said that the 5,000f. which he has given on the King of the Belgians' list for the development of Africa is the exact amount of the prize awarded him by the academy for his works in piercing the Isthmus of Suez. He spoke highly of the practical character of tbe work initiated by Leopold II, and advocated the junction by a canal of the Congo and Zambesi. The one falls into the Atlantic, the other into the Indian Ocean, but they approach each other within 30 kilometres. [*Mines, Metals, Arts and Railroad Journal*, v. 274]

Engineering Items.—The East River Bridge has now nine wire ropes in position stretched from the New York to the Brooklyn anchorage, over the two towers, preparatory to the construction of a foot-bridge and other facilities for putting together the cables. —Chili has one million acres under cultivation by irrigation, it being estimated that one-third of the value of the entire farming land of the republic is expended in the enterprise. Wherever irrigation has been introduced the land has increased in value threefold. —Spades are trumps again in Paris, just as much as in the days of Haussmann under the empire. The shovel and pickaxe are seen everywhere clearing away rubbish to charm the eyes of the visitors to the great exhibition of 1878, which the French hope will eclipse all its predecessors. [*Eng. News* iii, 384.]

MINING, METALLURGY AND MINERALOGY.

Ferro-Manganese.—This metal, which has of late attracted considerable attention as a substitute for spiegeleisen in Bessemer steel manufacture, is made at the Terrenoire Iron Works, in the following manner. The manganese liquor produced in the manufacture of bleaching powder, is precipitated by means of lime; the precipitated oxides are mixed with a necessary quantity of the purest iron ores (generally powdered magnetic ore from Algeria), and the mixture cemented together, after the addition of 15 per cent. of pure coal dust and a little fluor spar, with bitumen. The bricks thus formed are heated in a furnace (four-dormant) preparatory to their being transferred still glowing into a Siemens' furnace. The goal of the operation is the reduction of the metallic oxides and their fusion. Both operations demand an exceedingly high temperature, inasmuch as manganese is very difficult of reduction, and the carbon powder distributed throughout the bricks, forms a notable hindrance to the uniform heating of the ore. In addition to these difficulties, the slag is a most difficultly fusible one, being highly basic; since the presence of silica in the operation is specially to be avoided. The manganese and iron ores employed must be free from sand and clay, and the hearth of the furnace must be formed of an agglomerate of graphite, the successful production of which has but lately been achieved. So soon as the attendant notices that the masses begin to fuse, he adds a certain quantity of spiegeleisen rich in manganese, and brings the charge to complete fusion. The product contains often as much as 65 per cent. of manganese.—] *Deutsche Industrie, Ztg.*, 1876, 458.]

—A mass of meteoric iron, found in the Province of Santa Catarina (Brazil), contains, according to a report by M. M. Guignet and Almeida, 36 per cent of nickel.

Coal Fields of Utah.—Prof. J. E. Clayton, who has lately made an examination of the coal fields of Wasatch County, Utah Territory, attaches considerable importance to them. The beds, which are quite extensive, are not less than three in number; the principal one (the Hutchings) being 32 feet in thickness. About one half of the coal possesses excellent coking qualities. The beds are located at an altitude of about 7,750 feet above the sea level, and are not difficult of access.

A Possible New Metal.—Prof. G. A. Kœnig, of the University of Pennsylvania, announces that he has reason to suspect the existence of a new metallic element in a mineral resembling schorlamite, occurring at Magnet Cove, Arkansas. In an examination of this mineral, he obtained, instead of titanic acid, a white oxide which differed very decidedly from the former. He is disposed to regard this circumstance as pointing most probably to the existence of a new metal in the mineral in question.

The heaviest metal, according to late investigations of Deville and Debray, is osmium, the specific gravity of which they announce to be 22·477. —For heating water-baths to a high temperature, Gruin & Corine recommend a solution of chloride of calcium in glycerin, whose boiling point is between 300° and 330° C., which does not solidify, and has no corrosive action on metals.

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Flax Paper.—The New Zealand *Gazette* says that the flax of that country has lately come to the front in a new character; rope, matting and linen cloth have all been manufactured from it, and now it is presented in the shape of good, serviceable wrapping paper, card-board and roofing for houses. The mills for carrying on these operations have been named the Kaihu, and are located in the district of Northern Wairos, where a very considerable plant has been erected, at a cost of between one and two hundred thousand dollars.

An examination of the wrapping paper, card-board and roofing felt, thus produced, shows that, in respect to both quality and cheapness, the market affords nothing preferable. The paper is of a fine close texture, and almost as strong as parchment—it will tear, but not break; and the prepared material for roofing purposes is not only of superior adaptation, in point of quality, to the usual descriptions of felt roofing, but it is furnished at a much lower price. The matting manufactured from the flax is also found to have the advantage, not only of being much cheaper than the well known coir matting, but trials of the fabric prove that it will stand three times the wear and tear. [*Paper Trade Jour.* v, 394.]

Drying Apparatus.—In the appartment of the new and magnificent scientific structure erected in Oxford, England, allotted to the experiments in electricity of high tension, an apparatus of remarkable ingenuity has been provided for keeping the air of the room dry.

This apparatus consists of a heated copper roller, over which passes an endless band of flannel; the roller is heated by means of gas lights within it, which, being constantly burning, cause every part of the flannel to become hot. The vapor which arises from the heated flannel is carried off by the current of air which supplies the burners inside the roller. The flannel, when thus dried and cooled, passes into the open air of the room, where it again absorbs moisture, and thus the air of the room becomes so dry that the electrical instruments are preserved in a highly insulated condition, thus admirably meeting all the requirements of the case. [*Paper Trade Jour.* v, 393.]

A New Solvent for Copal.—Oleic acid is said to be an excellent solvent for gum-copal. On heating a small quantity of oleic acid it will dissolve a considerable quantity of copal. It is always a good means of distinguishing genuine amber from the imitation amber which contains copal. [*Druggist's Circular* xx, 199]

Uses for Cork.—Some additional experiments with cork as a substitute for India-rubber, in machinery, says the *Trade List,* are said to show its peculiar advantages for springs, especially under those circumstances where the pressure is very great. Extreme pressure will, it is well known, destroy rubber, causing it to break or split up into small pieces, losing its elasticity and seaviceableness entirely.

It is found that no such damaging result follows in the case of cork, if it is treated in the requisite manner. This consists in first soaking the substance in a mixture of water and molasses, which gives it some softness and permanent moisture, and is then cut into discs about eight inches in diameter. As many of these as are needed are put into a cast iron box, and an iron lid applied, the lid and corks having a hole in the centre. The corks are by this operation pressed down to half their original thickness, a bolt is run through the centre, and nut and screws hold them in place. A spring thus formed, tested by a ten-tons pressure, shows an elasticity which is said to resemble that of compressed air, and it is believed that, in certain cases, the introduction of springs of this material will be very useful.

Loss of Light by the Use of Globes.—In a valuable article on gas-burners, lately read before the Newcastle-on Tyne Chemical Society, Mr. John Pattison, in referring to the subject named, remarks :—

"It is not generally known what a very large proportion of light is obstructed by the glass globes or moons so frequently used over gas flames. From experiments, all made with a light equal to fifteen standard candles, I find the following results :

	Illuminating power.	*Percentage of light lost.*
Naked flame	15·00	.....
Clear glass globe	12·80	14·65
Ground glass globe	11·40	24·00
Opal globe	9·00	40·00
Another opal globe	8·16	45·60
Do do	8·00	46·70
Do do	6·64	55·90
Do do	8·00	46·70
Do do	7·48	50·10

The advantage arising from the use of these moons is that they diffuse and soften the glare of the naked light, which is sometimes oppressive to the eyes. Of the opal globes the dead white semi-opaque one should be avoided. A very good form of globe is that with a wide opening at the bottom, which allows a considerable amount of light to be reflected downwards from the white surface of the inside of the globe."

The Preservation of Timber.—The *Journal of the Society of Arts,* in speaking of the preservation of timber, says :

Buried in the earth or exposed to the air, timber rapidly deteriorates, and undergoes the species of decomposition known as dry rot. This decomposition may be retarded by the application of a coat of paint to the timber exposed to the air, or by carbonizing the surface of that which is intended to be sunk in the ground.

During the last twenty years, several methods have been tried for making timber more durable, ths principle of which consists in expelling the sap remaining in the ligneous fibres, in order to replace it by chemical solutions, such as sulphate of copper and creosote; but these processes, comparatively costly, and only partially successful, do not entirely accomplish their object. Starting from the fact that oak, chestnut, and certain American trees resist the action of air and damp better than others, and that they owe this property to the tannin which they contain, a chemist proposes to tan the timber by substituting for the sulphate of copper and creosote a compound of tannic acid and iron. The object of injecting various substances into wood is to poison it, so that the germs and microscopic growths may no longer live and propagate either on the surface or in the interior. Now tannin is one of the most active and certain destroyers of germs both vegetable and animal, which fact accounts for its preservative agency. Besides, it is to tannin that is due the almost indefinite preservation of leather. One peculiarity to be noticed in this process is that timber treated with this compound of tannin and iron, that is to say a composition similar to ordinary writing ink, is turned black. The process of injecting timber with tannate of protoxide of iron is due to M. Hatzfeld; the Eastern Railway Company of France has experimented with it on some sleepers, and the Telegraph Department on some posts.

M. Boucherie has denied, in a note to the Academie, the efficacy of this process, contending that the attempts already made to preserve timber from dry rot by injecting it with iron salts have yielded only partially successful results, while sleepers treated with sulphate of copper have lasted twenty-

five years and more. Reply is made to these objections by quoting—not the experiments of the laboratory or the workshop, but those made by time itself. It is not a rare circumstance to encounter in earth of a ferruginous nature the trunks of very old oaks, blackened and perfectly preserved; at Rouen, in 1830, some old oak paling was discovered as black as ebony, and dating back to the middle ages. Not very long ago, too, a Norman vessel built of oak was discovered in an almost perfect state of preservation in the neighborhood of an iron mine, in Norway. It is more than probable that the preservation of the oak under these circumstances is due to the tannin contained in the wood; it follows, therefore, that by introducing a substance rich in tannin into timber that does not naturally possess it, its resistance to decay is increased.

The Spirophore is an apparatus for producing artificial respiration in drowned persons. It is an air-tight iron cylinder, with a flexible diaphragm fitting the neck; the body is placed inside the cylinder, with the head protruding, and a suitable pump of large capacity alternately exhausts and compresses the air surrounding the body, and thus produces artificial respiration.

Fossil Wax—The substitution of fossil and of vegetable wax in place of the higher-priced beeswax assumes constantly increasing proportions. One factory alone—that of Frankfort-on-the-Oder—produces upwards of 100,000 lbs. of ceresine annually. This is the name of the purified product obtained from ozokerite, an impure fossil wax, found chiefly near the large coal beds of Doohobien and Boryslaw in Galicia, Zeston in Austria, near Newcastle in England, and in Texas. The crude substance, freed by fusing from the sand, clay, and other impurities, is of a deep brown color with greenish tint, has a specific gravity of 0·940 to 0·970, and exhales a benzine-like odor.

Methods Employed to Determine the Nature of the Coloring Matters Introduced into Wines.—A report by MM. Balard, Pasteur, and Wurtz.—To detect indigo, which is often used in the shape of sulphate, the authors add a little sulphate of potassa, and precipitate with chloride of barium. The sulphate of baryta, after filtration and washing, appears white if the wine is free from indigo, but if that dye is present it has a decided blue tint. Magenta is probably never employed alone in the fraudulent coloration of wines, but along with indigo it can be made to produce vinous reds. To detect this dangerous impurity, the authors agitate the suspected wine with a small quantity of amylic alcohol. This withdraws the dye, and collects upon the surface of the wine, where it forms a bright red stratum. If this rose-colored liquor is treated with a small piece of clean white silk, not mordanted, the latter takes the well-known shade of magenta, which turns yellow if the silk is touched with a drop of hydrochloric acid. An appendix by Dr. Stierlin gives a tabular view of the behaviour of different reagents with wines colored with dyes as compared with pure red wine. [*Bulletin de la Société d'Encouragement pour l'Industrie Nationale, No.* 34, *October*, 1876—*through Chem. News.*]

MISCELLANEOUS.

Low-Flying Balloons, propelled by poling, are suggested by Mr. F. W. Brearey, to the British Aëronantical Society, as a good and tested mode of aërial navigation.

Our Silk Industry strikes the British manufacturers with alarm.

Wood Paving in Paris.—An experimental section of one of the streets in Paris is to be laid with wood paving shortly. Instead of being laid as in London, on creosoted boards, and filled with gravel and pitch, the wood blocks will be laid in sand, and jointed with sand or hydraulic cement. [*Eng. Mech.* xxiv, 287.]

The Contention between Giessen and Munich for the honor of being the selected site for the memorial statue of Liebig has been settled by awarding a bronze statue to each city. The sum collected amounts to £7,000. [*Eng. Mech.* xxiv, 278.]

A Fire Signal, to indicate the breaking out of a fire, which has lately been patented in France by Angelin, operates as follows:—When the temperature of the apartment rises above a predetermined point, a quicksilver thermometer is caused thereby to break, and the quicksilver runs into a dish, where by its weight it sets in motion a clock work. This last, is made to operate an alarm bell. [*Deutsche Industrie Ztg.*, 1876, 469.]

Explosion of Coal-Gas on Shipboard.—A terrible explosion of coal-gas occurred on Wednesday morning, on board the Allan steamer *Prussian*, while lying in the Wellington Docks, Liverpool. Fourteen men were injured, some of them seriously. A quantity of wet coal had been taken on board, and the hatches closed. When they were taken off on Wednesday morning, there was a rush of gas, which ignited at the lights carried by the workmen. [*Iron*, viii, 717.]

Enlightened Legislation.—One would think that with this decisive expression on the general subject [*i. e.* vivisection], and with this complete vindication of the aspersed parties, the agitators would have been rebuked, and the case at once dismissed. But the anti-vivisection movement was quite too formidable to allow of this. The hysterical ram page of British philanthropy was strong enough to coerce the Government against its own protestations, and to extort from it a law that was alike an insult to science and a disgrace to the country. The physiologists were expressly acquitted of all improper practices when left free as they had always been, to pursue inquiries in their own way, and they were then handed over to the future control of the police. They were vindicated from all imputation of cruelty, and then subjected to the operation of a statute against cruelty to animals. Though their experiments had for their object the ultimate mitigation of pain to the higher creatures most susceptible of pain—though their investigations were of so beneficent an influence that, as Prof. Tyndall justly says, "no greater calamity could befall the human race than the stoppage of experiments in this direction"—yet the physiologists were classed by law with those cold-blooded brutes who cruelly over-drive, abuse, and torture domestic animals. Though the necessity, and form, and extent of his experiments on animals were, in the nature ot the case, matters of which the operator alone could judge, as their essential object is the elucidation of undetermined problems, yet it was legislated that he should not pursue his work except by a licence from a political office-holder, and the making of any experiment calculated to give pain to an animal was declared an offence punishable in the first instance by fine, and in the second by fine and imprisonment, unless certain conditions were complied with to the satisfaction of the said political functionary, who was put in control of the whole business. In short, legislative wisdom, stimulated by philanthropic zeal, outlawed vivisection as a crime, and then provided for its perpetration by leave of the Secretary of State. [PROF. YOUMANS, *in Popular Science Monthly for January.*

Wool and Hair under the Microscope.—The *American Naturalist* furnishes some interesting facts on this subject. The United States Treasury Department has admitted hair goods free from the duties levied on those composed in part of wool; and evidence having been furnished that some fabrics, claimed as made of hair, contained more or less wool, a commission was appointed, in which Dr. J. G. Hunt, the well known microscopist, was associated, for the examination of these fabrics. The possibility of distinguishing in manufactured mixture the hair of the cow and calf and that of the sheep has been denied by some microscopists, especially as these fabrics vary on different parts of the same animal. The commission has, however, been able to classify and distinguish them. Wooly hairs have no pith, and no preceptible taper. Their mean diameter varies from a five-hundredth to a thousandth part of an inch. At irregular intervals they have one-sided spiral thickenings, causing the wool to curl. They occur on sheep, camels, goats, llamas; and many other animals have a portion of these wooly hairs. On the other hand, straight hairs are shorter, thicker at base and tapering. The pith is a large part. The scales on the outside, of which there are twenty to forty in a hundredth part of an inch, lie smoothly. In wool they project more or less, and are from fifteen to thirty in the hundredth part of an inch. With these and other distinctions before them, the commission found, by first bleaching the colored fibers in mineral acids, and then mounting them in glycerin, and by using high powers, that in a few samples there was no wool; in a larger proportion there was a small quantity; in a very large number of samples there was from five to ten per cent., as well as a much larger proportion; and in two cases it was difficult to find five per cent. of genuine cow hair.

Horned Men in Africa.—There was a paper read before the British Association, written by Capt. J. S. Hay, relating to a strange malformation in the males of a tribe of people he has visited in Akem, in West Africa. An extract is as follows: Two diagrams which are laid before you depict to the best of my ability, and will at least convey some idea of a malformation which is, I believe, peculiar to this tribe. I have at least noticed it in no other. The malformation in question is confined to the male sex, and consists of a protuberance or enlargement of the cheek bones under the eye, which take the form of horns on each side of the nose. The malformation begins in childhood, but is not, so far as I am aware, hereditary. It presents no appearance of being a diseased structure, nor is it a raised cicatrice, after the fashion adopted by many African tribes. On the contrary I have seen children with this peculiarity of structure, whose parents were doing their utmost, though ineffectually, to stop it by medicines and applications. In the mean time, to set all speculations and conjectures at rest, and to corroborate a statement that doubtless may appear extraordinary, I have lost no time in writing to a missionary, a native of the country, to procure me, if possible, skulls in which the phenomenon appears; and as soon as these arrive it is my intention to exhibit them, in connection with a paper on the subject, which I propose to read at the Anthropological Institute in England.

Spontaneous Ignition of Lampblack.—Within three years, says the *Commercial* (Boston) *Bulletin*, there have been three shops destroyed in Massachusetts from lampblack. A hand damp with perspiration, a drop of water, a bit of grease, or a sprinkle of oil, will create the combustion which will start the lampblack aglow like charcoal, and so ignite the package, and hence the blaze. In lampblack factories, while great precaution is taken to prevent fires, a rainy or sharp frosty day will start a dampness upon the inside of a window pane, and the flying particles of dust lighting upon this creates a spark which, communicating with the pile, sends a glow of fire with wonderful rapidity through the galleries of the shop. In cleaning up the smoke galleries, if the men let a drop of perspiration fall into a pile. they instantly scoop up the lampblack in and about where it lodges, and carry it out of the house.

Deep Walnut Stain for Light Woods.—The employment of alkaline manganates for staining light woods in furniture and floors a beautiful, uniform, and durable walnut brown, is highly recommended by Viedt. The action depends upon the decomposition of the salt in the pores of the wood, with the separation in them of very finely divided brown hydrated peroxide of manganese. In practice, addition of magnesium sulphate to the solution hastens the reaction. The process may be conducted as follows:—Dissolve equal parts of manganate of soda and crystalized Epsom salt in twenty to thirty times the amount of water, at about 144°, and brush the planed wood with the solution. The less the water employed the darker the stain, and the hotter the solution the deeper it will penetrate. When thoroughly dry, and after the operation has been repeated, if necessary the furniture is smoothed with oil, and finally polished. It is well to wash it carefully with hot water before smoothing it to prevent the efflorescense of the sulphate of soda formed. For floors the solution may be employed boiling hot, and if the stain is not dark enough a second application of a less concentrated solution should be made. After it is perfectly dry, it should be varnished with a perfectly colorless oil varnish. On account of the depth of penetration of the stain, a fresh application will not soon be required. [*Canad. Mech. Mag.* iv, 371.]

A Cotton Picking Machine for our Southern cotton fields is earnestly demanded.

BIBLIOGRAPHICAL NOTICES.

Catalogue Anatomique, Preparations Naturelles et Artificielles de Tramond successeur de Vasseur. Rue de l'Ecole de Medicine, 9, Paris.

The above catalogue of anatomical preparations which has just come to hand comprises an immense number of specimens, natural and artificial, (in wax papier-maché, and carton pierre,) affording illustrations of normal and pathological anatomy in immense variety. The catalogue is introduced by a most complimentory report of the international jury of the Paris Exposition. The preparations of M. Vasseur are surprising imitations of nature, and are represented in almost every museum in the world. It may interest the medical profession to learn that an American office for the sale of these admirable aids to medical and surgical study will shortly be opened in Philadelphia under the charge of M. J. Vernier.

The Normal Higher Arithmetic, Designed for Advanced Classes in Common Schools, Normal Schools and High Schools, Academies, etc., by Edward Brooks, A. M., Principal and Prof. of Mathematics in Penna. State Normal School, etc. Sower, Potts & Co., Philadelphia.

A thorough text-book, which will be found to be admirably adapted for the purpose designated by the author.

Common School Literature, English and American, wtih several hundred extracts for literary culture, by J. Willis Westlake, A. M., Prof. English Literature in the Penna. State Normal School, etc. Sower, Potts & Co., Phila.

The author gives, in this little book of 156 pp. (12mo), an historical sketch of the growth of English literature, with comments on the peculiarities of each era, and extracts from the works of representative authors. It is well calculated from its arrangement and the felicity of the numerous quotations, not only to familiarize the student with the history of the subject, but likewise to develop that taste for it which is the basis of general culture.

The list of authors with their nomdeplumes, and the many miscellaneous extracts from the standard works of authors of celebrity, which the author has added to the work proper, render it both interesting and useful to a wide circle beyond the school room.

EDITORIAL CORRESPONDENCE.

EDITORS "POLYTECHNIC REVIEW:"—How to render our Theaters and Public Halls safe, and prevent a repetition of the Brooklyn horror, is a question that must not only be solved, but must be practically applied, before public confidence will again be re-established. The patronage of our public places of amusement will doubtless depend, in no small degree, upon the thoroughness with which this is done. Many plans have and will be offered, nine-tenths of which are by persons of no mechanical training or engineering ability. Crudeness and impracticability are the rule in nearly every case thus far suggested.

Automatic machinery is now used for doing very nearly everything except to extinguish a fire.

In our great silk mills, where hundreds of single threads are being twisted or braided together, the breaking of a single delicate filament will bring the whole ponderous machine to a state of rest. Fire will instantly divide a strong cord, and should the cord be of cotton and put in the chemical condition of gun cotton, it will be caused to disappear instantly, by a temperature of 300° Fahr., a degree of temperature barely sufficient to melt soft solder, and too low to ignite or char wood or cloth; yet sufficiently high to be far beyond that caused by anything except a *bona fide* fire.

I now propose to show how an automatic device or apparatus may be constructed and arranged, that will not only detect the existence of a fire, but will also apply the extinguishing agent, at once and to the very spot, without damaging any place where no fire exists, and that too with a single system of pipes. The whole to be quite able to act intelligently of itself at any time, without either human presence of mind or body.

Let there be placed in the basement or the cellar of the building protected, a large and strong tank, having a dome on its top, after the manner of steam-boilers. Into the tank put an aqueous solution of bi-carbonate or super-carbonate of soda, and into the dome a glass bottle or carboy of sulphuric acid, so arranged that on the breaking of the bottle the acid would be precipitated into a perforated plate and fall in many streams into the solution or soda water. There should also be a quantity of marble dust (carbonate of lime) on the bottom of the tank, to combine with what acid might fall to the bottom from its greater specific gravity. The bottle should be carefully sealed, so that no slow combination could take place, and thus deteriorate and render inert the whole mass. Let the bottle be sealed in the dome, and both acid and soda water excluded from the external air, and no change will take place in the chemical constitution of either, no matter how long they may remain before being used, neither will they evaporate or corrode the tank. From the bottle and through the top of the dome would extend a strong copper rod, its lower end resting on the bottom of the bottle. Suspended over the copper rod would be a suitable iron weight, held in its place by a catch or prop, the removal of which would allow the weight to fall and drive the rod through the bottom of the bottle.

A pipe would lead from the bottom of the tank, and branch out into all exposed places.

Let one or more pipes run up each side of the stage, and branch out into six or more smaller pipes leading horizontally half across the stage; there would thus be twelve or more pipes, each to be perforated to cover its particular section of the stage and scenery. These pipes should as far as practicable be over the flies. Each of these sprinkling pipes would be supplied with an independent valve at its junction with the main pipe, and each valve held firmly to its seat by a cord which would extend over the section covered by its accompanying pipe; such a cord could be so arranged that it would traverse two or more times over the section; passing over all the more dangerous points in such a manner that the severing of it at any point, would allow the valve to open or allow a weight to fall that would jerk the valve open. But how is this to break the bottle in the dome of the tank hundreds of feet distant? When the pipes are all properly arranged and all openings made perfectly air-tight, a light pressure of air may be pumped into them; this would constitute a species of pneumatic telegraph from the locality of the fire to the acid in the bottle. The light pressure in the pipes would act on a suitable diaphragm-Mercury-float that would hold the prop or catch under the weight. A loss of this pressure would allow another force to withdraw it.

It would be somewhat like the damper regulator used in steam engineering, where too little pressure in the boiler opens the damper and too great a pressure closes it.

The whole being now properly charged and adjusted, let us suppose a fire to occur in any one of the protected sections. The first flash of flame or increase of heat would divide the cord passing through or over it; the valve would be opened; the light pressure in the pipes would instantly escape; there would be no pressure at the tank to hold the catch under the weight, consequently it would fall and the acid would at once be precipitated into the soda water, where it would at once generate an immense pressure by combining with the soda and liberating the carbonic acid gas contained in it. This pressure, so instantaneously generated, would as instantaneously force the water charged with carbonic acid gas out of the only openings which would be those directly over or covering the locality of the fire. Should the fire spread or break out in more than one place, then more openings would be made, the water, as it were, following the fire; while should there be one immense outbreak of flames like a gas explosion extending all over the stage, then all the pipes would be opened and all inflammable material thoroughly flooded with the most potent of all extinguishing agents, viz., carbonic acid gas and water. Branch pipes could be extended into all the rooms, large or small, in or about the theatre. Those in the smaller rooms might have a single closed opening, with a cup composed of a metal that would break easily when at 300° F., or it might be made to melt completely at that point. A better way, however, would be to have a small groove or annulus in or about the cup filled with a thread of gun cotton; the end might hang out loosely or might be drawn across the room to suit the requirements of the case. The explosion of the cotton would make a clear opening by snapping the cover off. Portions of the stage could also be protected in like manner where no room existed for the perforated pipes; such openings could be fitted with nozzles of sufficient size to throw water to a considerable distance. One or more branches should have hose attached. But as hose is usually connected and arranged, it is far from perfect. A short length, if ready coupled, will not often reach so far as is desirable; while a long length is liable to become kinked and thus stop the water, or burst; while changing the length occupies altogether too much time and presence of mind. What is required is stiff hose that will not collapse, coiled loosely around a reel, the shaft of which is connected to the system of pipes and the water entering at the shaft or trunion, as steam enters the cylinder of an oscillating engine. It should also be arranged so that the first turn of the reel would open the connection to the pipes. With a reel so constructed, with a box or casing about it, and only the end of the nozzle projecting, it would be constantly ready for instant use, and all that would be necessary to set the whole in operation, would be to seize hold of the nozzle and advance to the fire; by the time ten feet could be drawn out, the discharge would commence. One apparatus of this kind could be made to protect any number of adjoining buildings. The falling of the weight might also be arranged to operate a suitable telegraphic alarm, that would announce the existence and locality of the fire at the office of the fire department; and as there would be no sleeping nor neglect of duty on the part of the extinguishing apparatus, it could be relied on at all times and under all conditions, whether day or night, or whether any person be present or not.

This same system of pipes could also be used to advantage in connection with an elevated tank using water only. But an elevated tank is objectionable from several reasons, viz., in this climate they would be apt to freeze in winter; water would be liable to leak into the pipes and, on freezing, would burst them; besides they might be obstructed with ice at the very moment wanted. Elevated tanks could not conveniently be placed at a height sufficiently great to produce the necessary pressure; for a maximum result there should be at least one hundred pounds pressure to the square inch, and this would require that the tanks be placed somewhat over 200 feet high, and this is out of the question. Still, water from a tank 40 feet high acts well as a sprinkler, but not satisfactorily for hose. As water is about ten times as efficacious for extinguishing fire when charged with carbonic acid gas as when used alone, the elevated tank would require to be ten times as large as the one heretofore described containing the soda solution. The effects of water charged with carbonic acid gas upon a fire inside of a building is something truly wonderful, and can only be accounted for upon the hypothesis that the gas is drawn towards the fire by the draft of air, and that in raising up about the fire it effectually closes out the air like a box. It is drawn up about the fire in a pile and extinguishes it as a wet blanket would, or a pile of any other non-conducting material heaped about it. It must also be remembered that the volume of the liberated gas is many times greater than that of the accompanying water, and that while in the tank and pipe it exists as a liquid dissolved in the water, it at once, on its escape from the nozzle, assumes a gaseous form and serves in no small degree to diffuse the water into a spray.

I have visited many cotton mills, and while I have much admired the marvelous machinery that seemed "almost gifted with intelligence," I have been surprised at the crudeness of their fire apparatus. In some mills I noticed a series of sprinkling pipes, but should a fire break out in one corner of a large room, much time would elapse before the water could be let on, and then the whole room would be flooded, as would all the rooms below, and thus much damage be done by water, in some cases a thousand times more than by the fire. There is something obviously wrong in this. Having had a great deal of experience in designing and constructing automatic machinery, I venture to submit this plan for the careful consideration of a critical public, hoping that if the inertia of human nature is not too great to embrace radically new ideas, that I may some time see theatres, public halls, cotton mills and hotels provided with a sensible means of combatting fire.

Very truly yours,

HIRAM S. MAXIM, Mechanical Engineer,
176 Centre Street, New York.

[In our next issue we shall publish some illustrations and details relating to the application of Mr. Maxim's mode of extinguishing fires —Eds.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ACADEMY OF NATURAL SCIENCES.

(Abstract of meeting held Tuesday, December 12th.)

At the meeting of above date, amongst other matters of interest which transpired, we note the following:—

Dr. Leidy called attention to a specimen of a bituminous-like matter said to be produced by the deposit of the renal secretion of Hyrax or Rock Rabbit. The substance is used in South Africa, where it is found, as a remedial agent, under the name of Hyraceum in hysterical, nervous, and spasmodic affections. It is said that in a long standing case of hypochondria, accompanied by strong hysterical symptoms, and which had baffled the skill of several practitioners, a teaspoonful of the tincture produced a rapid and decided cure. Dr. A. Brown states that in all cases where Castoreum is recommended, he had found Hyraceum far preferable as an antispasmodic; in hysteria itself he had found it invaluable. The specimen of this substance belonging to the Academy was presented by H. C. Coates, Esq., Centennial Commissioner from the Cape of Good Hope.

Professor Cope spoke of a material found in fissures of the rocks in New Mexico which resembled Hyraceum, and which was probably the fecal and renal deposit of the Wild Rat, Neotoma.

Mr. Goldsmith described a mineral from near Colorado, presented to the Academy by Dr. Leconte. The composition was found to be that of a soluble sulphate of alumina and magnesia, as in the old form of Pickeringite.

Professor Blake exhibited specimens of flexible sandstone from Mariposa County, Cal., a new locality for this mineral. The specimens are remarkable for their great length, some being 32 inches long and capable of being deflected 7½ inches. There is very little resistance to bending until a certain point is reached, when it cannot be bent farther. The specimens can also be elongated, which is a remarkable peculiarity of sandstone or itacolumite from the region mentioned.

Mr. Joseph Willcox added that all the specimens of itacolumite he had heretofore observed were distinctive of their respective localities; the specimens described by Professor Blake, however, resemble exactly those from Stokes county, N. C.

The cause of the flexibility of these sandstones was considered by Professors Frazer, Blake, and Leidy.

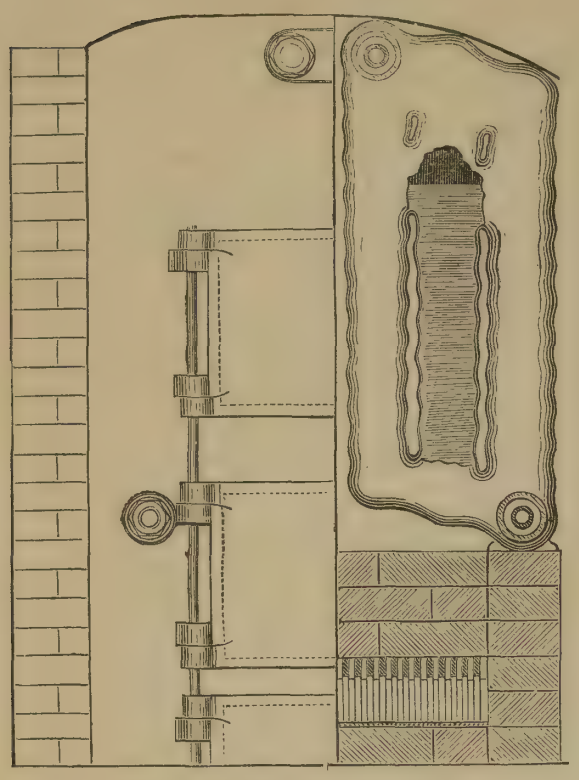
Mr. Young called attention to an instance of the slow freezing of fluids in the Main Building, Centennial grounds, in the case of certain bottles of ink from which the corks had been forced out by the liquid, which had formed a frozen column of three inches in hight above the neck of the vessels.

Mr. Jos. Willcox stated that several of the minerals presented this evening were worthy of special notice. The specimen of polished serpentine from Harford County, Maryland, was harder and more beautiful than any he had before seen. The black tourmalines from Cumberland Gulf, north of Labrador, were the largest yet collected, and they add another name to the list of minerals which are found in larger specimens in America than elsewhere. Mr. W. mentioned, in further illustration of the occurrence of unusually large specimens of minerals in America, the crystals of mica and apatite in Canada, beryls from Acworth, N. H., scapolites from St. Lawrence County, N. Y., and feldspar from Delaware County, Pa., and Buncombe County, N, C., rutile from Georgia. He stated that many others could be mentioned in this connection.

Mr. Goldsmith spoke of the white incrustation which appears so extensively at present on the brick walls of the city. He stated that Mr. William H. Dougherty had recently analyzed a quantity of the substance, and determined it to be sulphate of magnesia. The magnesia was found by Mr. Dougherty to occur in quite large percentage in the lime of the mortar between the bricks, and he believed, from the evidence of further analysis, that the sulphuric acid was a product of the combustion of coal, etc., in our dwellings.

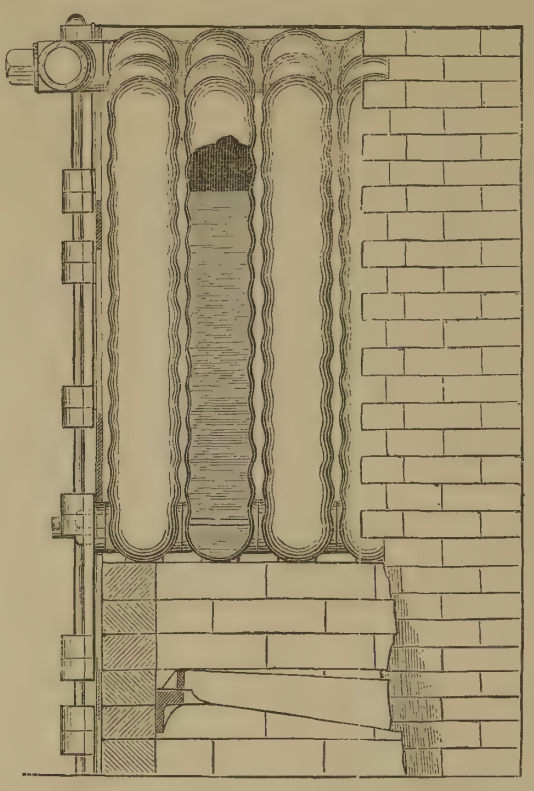
Mr. Vaux stated that crystals of tourmaline fully two feet long had been seen by Lieutenant Mintzer at Cumberland Gulf, north of Labrador.

CENTENNIAL NOTES.



REED'S SECTIONAL SAFETY BOILER.

The cuts show the mode of construction of this steam generator, which was exhibited in Machinery Hall. The boilers are cast in sections of one H.P. each in the medium sizes; their sections being rhomboidal in outline, and consisting each of three vertical pipes, connected at, above, and below the water line; the two inside pipes being tapered in order to give ease of circulation, and facility for combustion and heating; all of the pipes being corrugated, in order to increase the heating surface and at the same time allow for expansion and contraction without leakage. These sections are connected with each other at two diagonal corners, by faced joints, with perforated horizontal wrought iron pipe, serving as tie-bolts while affording good steam and water communication, and diminishing priming and that sudden rising of water from the bottom, common to many tubulous boilers. Each section is stated to have 12 square feet of heating surface. The circulation in each section is upwards in the two

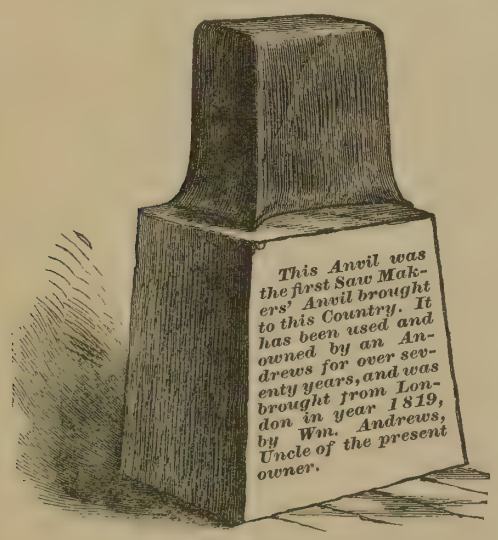


inside tapering tubes, these being the hottest, over the middle connection, and downward in the outside pipe (which rests on brick work and is consequently the coolest,) and which pipe is not tapering.

The makers* state that they test each section to 700 lbs. hydraulic and 300 lbs. steam pressure; and that one of them† has been running for five years, frequently at 220lbs. pressure. The effect of a possible rupture should be but an escape of steam or water, relieving the pressure; the remedy, simply the removing of the tie-pipes, and replacing the injured section. The sections weigh 200 lbs. each and hence have an advantage in transportation, especially where pack-mules must be used. The cost per H.P. is from $20 to $30, brick-set; the economy in repairs should be considerable, and the evaporation is guaranteed to be 13 lbs. of dry steam per pound of Harleigh, Lehigh or Buck mountain anthracite. G.

*Reed's Corrugated Sectional Safety Boiler Co., 113 Liberty st, New York City.

†Owned by Mr. A. E. Hoppuck, Newark, N. J.


This Anvil was the first Saw Makers' Anvil brought to this Country. It has been used and owned by an Andrews for over seventy years, and was brought from London in year 1819, by Wm. Andrews, Uncle of the present owner.

AN INTERESTING RELIC,

At the Centennial, in connection with the exhibit of Mr, E. Andrews, saw-maker, of Williamsport, Pa., is here with illustrated, appropriately inscribed. In this country of migration and change, it is unusual to note the continuance of several generations of one family in the same business—and ven with the same implements. Such "old-fogyism would, if more general, greatly improve the quality of those manufactures where judgment and skill in handicraft largely determine the excellence of the output.

THE BENSON IMPROVED STAVE MACHINERY.

(Shown in Machinery Hall)

A rived stave is fed on edge between two rollers and against the edges of two parallel and concentric curved bits or knives, which give it the required smoothness and sectional curvature. To joint and taper the smoothed and curved stave, it is fed on its face against the faces of two rapidly revolving cutters, each having four arms, and these arms interlocking and bearing on their faces the proper bits. The axes of these cutters being slightly inclined from each other, in the horizontal plane, the stave is dressed with a double taper on each edge; the required bevel being effected by a proper downward inclination of the face of the stave. G.

A LOCOMOTIVE RUNNING BY COMPRESSED AIR.

The use of compresed air in operating rock-drills and other stationary machinery, has become comparatively general since the last Paris International Exhibtion, where, if we mistake not, it was the first time shown to the public; but it was reserved for the Philadelphia Exhibition to show how this motor can be used in locomotive engines. And not only in engines for roads of low grade, but also for roads of grades too steep to be overcome by traction. The honor of this achievement would seem to belong to the students of the Polytechnic College of this city, or perhaps we may say to the manner in which they, under their instructors, apply the method of "self-help."

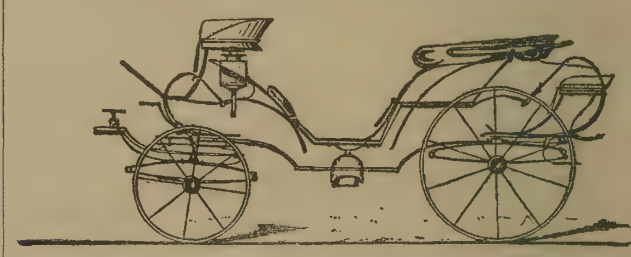
Their Monday morning meetings are, in fact, conversation meetings on machinery and public works, at which reports are presented on these subjects. The *periodicals are searched for novelties* and the matter in both discussed. In this manner the press is utilized, and we think we may claim for this invention, of whatever value it may prove to be, that is it one of the fruits of the introduction of the *current technical journals into the college class-room.*

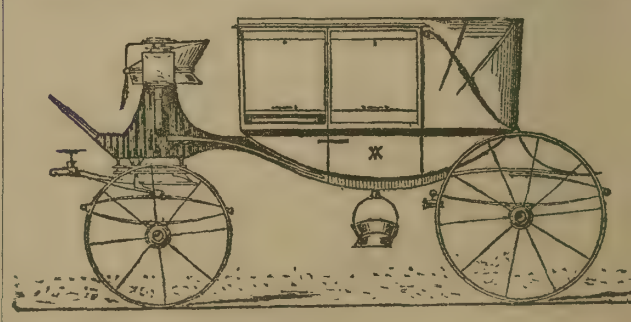
The students have constructed their model on the scale of an inch to the foot, and as it stood on its track in Machinery Hall, it somewhat resembled a steam locomotive. Of course there is no smoke-stack, or fire-box, or dome, or safety-valve, or injector, or water-cock. No fuel or water, and therefore no tender, or need of a fireman. But the air-chamber is cylindrical; it is set horizontally like a boiler, and stands on four wheels, which, as the model is made for steep gaades, and is in daily operation, running up a grade of one foot in five, of course are not driving wheels. The two cylinders are horizontal, and they as well as their pistons, valves, eccentrics, and the connections of these, are not unlike those in common use. But the driving wheels revolve horizontally, in the same plane, and in opposite directions. They are flat in their tread, having no flanges, and are set so low, one on either side of the middle line of the bottom of the air-chamber, that they embrace between them in the middle rail of the track. This rail unlike the T rails on which the engine runs, is a broad flat bar, set edge-wise, so that the whole of the wide tread of both driving wheels bears against the opposite sides of it. The pressure of the drivers on the middle rail may be increased in proportion to the steepness of the grade and the weight of the load. The drivers thus also serve the purpose of brakes, stopping or holding the engine as the engineman may press the lever. Before starting, the air-chamber is filled from the reservoir kept under pressure by a stationery engine and air-pumps. In the model the reservoir stands at the foot of the plane, and from it a three-eighth inch pipe runs the entire length of the track and just outside one of the T-rails. Outlets to this pipe, consisting of stop-cocks and flexible tubs are set at intervals, thus constituting "air stations," at which when the pressure falls too low while running, the engine may be halted and connection established between the air.chamber and the pipe-line. Almost instantly sufficient air passes into the former to bring the pressure up to that within the pipe, and the engine is ready to resume its journey.

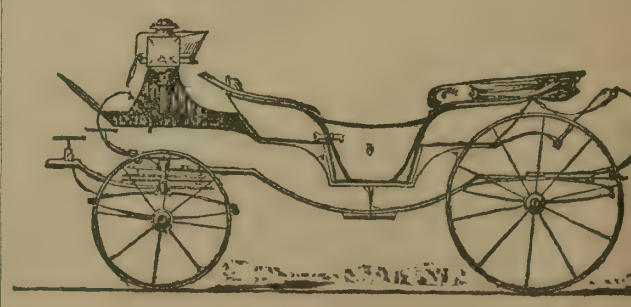
By this system of compressed air propulsion—which from its birth place might be called the *Polytechnic system,* the air is furnished by a series of relays, which would seem to remove the chief objection to the employment of this motor for locomotive purposes. The other feature of the system, by which friction driving wheels are substituted for the old rack and pinion, still generally in use in Europe and America, where locomotives ascend steep planes, may also be regarded as a marked improvement. The combination of these two features admirably adapts the system to mining purposes, especially where compressed air is to be introduced to drive the rock-drills or cutters. The substitution of compressed air for horses on our city passenger railways is alike the dictate of science and humanity, and we should not be surprised if the invention above described were to prove a long stride towards so desirable an end.

FRENCH CARRIAGES.

The annexed cuts show three styles of carriages exhibited by the house of Million, Guiet & Co., Paris. Thanks to the use of American hickory, these builders are now producing vehicles combining the lightness and grace which distinguish those of our builders with the solidity and strength more aimed at in England and on the Contiment.







THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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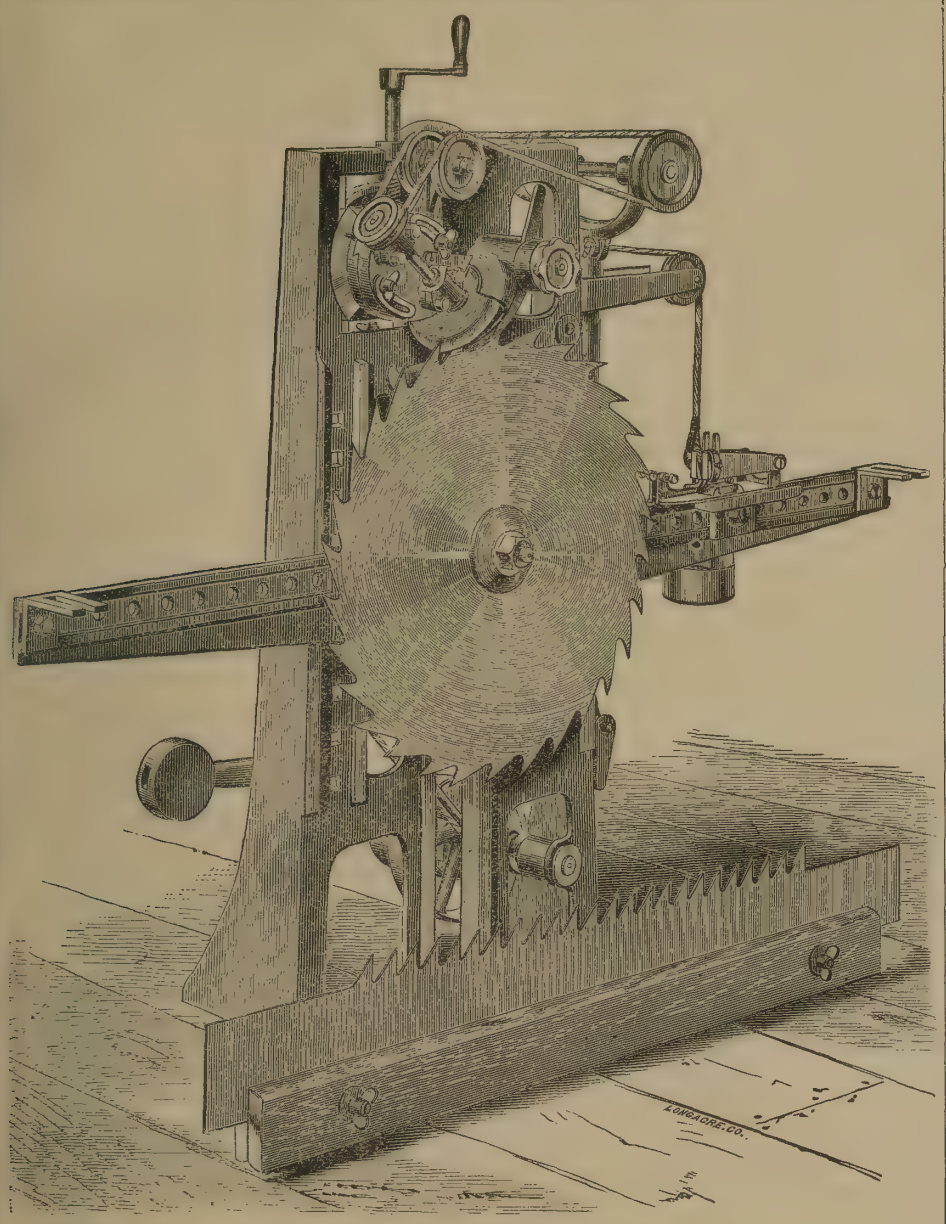

SAW MILL APPLIANCES.

THE KNOWLTON SAW-TOOTH GUMMER, TRUER AND SHARPENER.

(Saw Mill Annex, Centennial Exhibition.)

The makers * claim for this machine:

"1. To have one tool in a mill with which any person possessing an ordinary amount of mechanical ability can put a saw in *perfect* order. 2. Having a tool of such mechanical completeness for the purpose intended, and so simple and well constructed as not to be liable to get out of order. 3. A machine that is so near automatic and regular in its movements in feeding the grinding wheel to the saw that, with ordinary care, there is no danger of overheating the teeth. 4. That a person having any knowledge of running a saw can, with this machine, put it in *better order* than the best expert can do by hand; after setting it, all the cutting edges will be at right angles with the saw; all will have the same hook on the under side and the same clearance on the backs, as the circle of the wheel grinds both the bottom and top of the teeth concave. Both corners of the teeth will have a keen cutting edge, the same as some sawyers claim by filing the top of the teeth, beveling, and using a spring-set, in which case it requires one-third more teeth to do the same work, as only every second tooth cuts on either side and each tooth cuts but about two-thirds across the kerf. Furthermore, a circular saw put in order on this machine *will be perfectly round, and each tooth will do its portion of the work.*

The advantages of this machine are, that it takes no longer to dress a tooth that is spread and cuts on both sides than the one cutting on one side only, besides having the teeth stouter and more space for sawdust than the saw with so many teeth, and not only having one-third less to dress, but having more room to wear back, as teeth should always be dressed the most on the under side. A circular saw tooth will cut better with the edge of the tooth and throat concave, for two reasons:

1. Giving a keen cutting edge to the points. 2. Forming a trough in the throats of the teeth to keep the dust from passing out and gathering on the timber, forcing the saw to run out of its course and causing friction. Another very important advantage of this machine is the appliance for dressing off the sides of the teeth after being spread. This gives each tooth two bevels for clearance, one towards the centre or back of the saw, the other towards the back of the tooth, as the saw passes down through the timber and as the timber passes to the saw, preventing all friction on the sides of the teeth.

The largest machine will sharpen saws of any size, ranging from twelve inches to seventy-two inches in diameter, and straight saws of any length. Weighs about 550 lbs.

The small machine is made for planing-mills and car-shops, and will sharpen saws ranging in size from six inches to thirty-six inches in diameter, and straight saws of any length. Weighs about 450 lbs.

The attachment for grinding planer-knives weighs about 70 lbs.

To Sharpen Circular Saws.—After swedging the teeth, place the saw on the mandrel or arbor, raise it up to the proper height and stop the reciprocating movement; lower the head until the emery wheel touches the shortest tooth, after which turn the saw until it has ground the teeth true; then use the side filer to true the sides of the teeth and give them the proper width on the points; when that is done, set the heads to suit the size of the saw as indicated at letters B on the index, which gives the shape of the bottom of the tooth; then lower the head until the bevel of the wheel drops below the point of the tooth (this is to prevent forming a ridge on the cutting face of the wheel, which would spoil the points of the teeth), after the head is lowered, regulate the throw of the traversing head to suit the size of the teeth, hold the under side of the tooth against the wheel until it is ground sharp, which you can tell by observation, then raise the head, pass on to the next tooth and lower the head to the same distance as before, which can be arranged by the stop screw under the head; after grinding the under side of the teeth, set the heads to suit the size of the saw, as indicated at letters T on the index, which gives the shape of the top of the tooth; this requires more throw to the traversing head; place the notch of the crooked spring under the tooth that is being ground, which will hold the saw against the guide pin and keep the tooth in its proper place under the wheel; when grinding the top of the first tooth, lower the head until the tooth is sharp and set the top screw under the head to suit; you will then have all the teeth of the same length and the saw perfectly round. If the saw is out of round and there is much to come off the teeth, it is best to go over them the second time, as it reduces the grinding wheel a fraction when taking off so much of the saw.

Always be careful to adjust the guide pin to bring the saw central with tho spindle of the grinding wheel, so as to make the cutting edge of the tooth at right angles with the saw; if you wish to give the teeth a bevel, it can be done by setting the arbor in or out from the centre.

To Dress a Straight Saw, fasten the straight bar on brackets at a proper distance below the head; place the saw in the wooden clamp which slides on the bar, with the cutting edge parallel with clamp; lower the grinding wheel until it touches the shortest tooth and pass the saw from end to end; this will joint the edge; after which adjust the heads at letters B on index, so that the bevel of the wheel will form the bottom of the teeth in any shape required, the same as in sharpening circular saws.

For gumming or cutting out the throat of saws, use the round-faced wheel and set the head at any angle desired; hold the saw against the wheel, and, while grinding, raise and lower the head gradually, by which you can form the teeth in any shape required; where there is much to come off the saw, use the coarse wheel for cutting down."

*Estate of Jno. L. Knowlton, Sharon Hill, Delaware Co., Pa.

IMPORTANT ASTRONOMICAL OBSERVATIONS.

The great refracting telescope, of 26-inch aperture, of the Naval Observatory, Washington, has been diligently employed for some time past in observations of the satellites of the outer planets, Neptune, Uranus and Saturn. A few evenings ago, Professor Hall, at 6 P. M., Washington mean time, observed a brilliant white spot on the central lower portion of the disk of Saturn. On giving notice of this to our chief observatories in the different States, he has had the satisfaction of hearing from several of them that they have since observed the same. He has also watched it closely, for the plain object of determining by these series of observations the true period of the rotation of the planet; an inspection of the text books on astronomy shows a discrepancy in the statement of this period by the two Herschels. We anticipate the pleasure of presenting very soon the results of Professor Hall's investigations.

From the report of the Superintendent of the Observatory, Admiral Davis, to the Secretary of the Navy, we learn that in connection with the observations which have occupied the great telescope, further interesting discoveries have been made. The companion of Procyon, discovered by Struve, Director of the Imperial Observatory, St. Petersburg, has been diligently searched for without success; but three other close companions of the same beauteous star have been discovered through the lens of the great telescope. These companions have been repeatedly seen at the Observatory, and on their positions being given they have been recognized by American astronomers also at other observatories.

It may interest our readers to learn, in this connection, that a volume prepared at

the Observatory for the Centennial is now being distributed to those specially interested in astronomical pursuits, which contains a description of each of the telescopes of the Observatory, accompanied by a heliotype plate of the same; in connection with the several plates of the great refractor, a condensed report is given of its work on the planets, and on several of the larger nebulæ. The last heliotype in the volume presents the results of this work in a quadruple picture. The volume is entitled "The Instruments and Publications of the Observatory from 1845 to 1876.

"TEN MINUTE" PAPERS.

By PROF. J. E. SWEET.

III.

TOOLS AND THEIR USES.

I promised in my first paper to treat of the most indispensable of all the machine tools. And what can disable a machine shop more effectually than to destroy the *grindstone?* Unless the loss were supplied by the modern substitute, the emery grinder, to destroy the grindstone would be to wreck the shop. It seems that but little can be said in reference to grindstones, either as regards their construction or their use. And if our specimen is taken as the perfection of the species there would not be much to say, as it has but two merits. One, it makes a good picture in an iron-monger's catalogue; the other, it shows just how a grindstone frame ought *not* to be made. If any of you should amuse yourselves in designing a grindstone frame and should make a good one, it would be much better than designing a poor lathe or planer. A thorough study of the subject will develop more requirements than many think, and much ingenuity or skill in designing might be displayed in working out the problem. It should be strong, simple and clean; the trough expanded to catch as much as possible of the drip water and grit; a movable shield securely hinged to keep the water from sp ashing and yet admit of the stones being used from either side; rests provided upon which to rest tools and the rod for turning the stone, these rests arranged to move toward the center as the stone wears smaller. The bearings should be generous in size, proper provisions for oiling without washing the grit into the bearings with the oil, and the ends of the bearings protected by some device which effectually prevents the entrance of the grit. The stone should be secured to the shaft by nuts and washers, and the washers fixed so they could not turn with the nuts as they are screwed-up or unscrewed. In hanging the stone, great care should be taken to hang it true sideways, not only for convenience in using, but because *a stone that is not true sideways can never be kept true edgeways.* To fully comprehend the cause of this will require reasoning on your part, and if you take the trouble to reason it out, you will hereafter be more careful in hanging grindstones true than you will if you allow yourselves to go on in the belief that it is of no great consequence whether the stone is true sideways or not.

Suppose a stone to run one-fourth of an inch out of true sideways, and while in motion draw a line around it within three eighths of an inch from the edge on an average. From this line there would be but one-fourth of an inch of stone on one side and one-half on the other. If you had a stone only this in thickness, that is a stone one-fourth of an inch thick on one side and one-half of an inch thick on the other, would not the one-fourth inch side wear away faster than the other? That is exactly what it does on that side of the thick stone, only the thicker the stone and the less it is out of true, the less it wears—hence turn them on the sides until they run true.

In using a stone, the best grinders of edge tools have it run towards them. A beginner can generally do better with the stone turning from him, but as you want to learn the best way, practice with the stone turning toward you and you will soon get accustomed to it, and will then like it best. In turning a stone, that is in trueing one up when first set or when out of round, a small iron or steel rod is better than a large one. The best size for the rod depends upon the size or rather upon the power by which the stone is driven. The larger a stone and the more powerfully it is driven, the larger the rod can be. The reason why a small rod is better than a large one, is because, as the rod is ground away at the upper corner, a sharp one is formed at the bottom, and rolling the rod constantly presents a new cutting edge.

A drilling machine may not be next to the grindstone in importance in a machine shop, but in many places and for many classes of work, a drilling machine and drills are about the principal part of the kit. Until within the last fifteen or twenty years drills were almost wholly made by forging down steel to a size somewhat smaller than the size of the whole required, then flattening down the end until it was of the proper width—tempering and grinding the end of the same form as we now grind the twist drills. Flat drills, as they are called, are still used to a very great extent; some of the largest firms use them almost exclusively. Possibly a firm keeping a forger especially for tool-dressing may find such drills are the most economical, besides very many workman can get a hole just the size they want it better with a flat drill than with a twist drill. At first it seems that nothing could be more perfect than a twist drill, but if in grinding, the point is left a little one side of the center, or if the angle on one side is more acute than the angle on the other, then the drill is liable, or in fact is sure to drill a hole larger than itself. Besides the first cost of the twist drills and their liability to break a long way up from the end as they usually do, which of course adds to the cost, there are other objections; still, as a general thing, I think they are economical and certainly a great convenience, and the method of grinding the back away, as shown in Fig. 4, so as to make them weak at the point, is an improvement, for it is much cheaper to break off an eighth of an inch at the point than to break them two inches up.

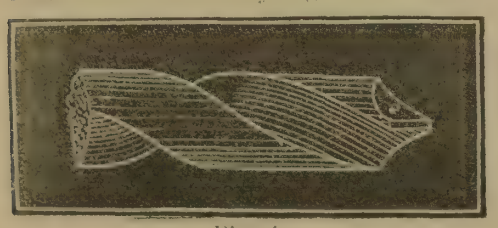

Fig. 4.

When I first adopted this method of grinding it was simply as a matter of convenience, but now I consider it better even than the theoretically correct form given to the drills as furnished by the makers, and reproduced by the beautifully ingenious machines invented by Van Haagen, of Philadelphia, and George Richards, of Winchendon, Mass. By grinding away the back as shown at *a* in the figure, one accustomed to grinding flat drills can grind the twist drill equally well, and the policy of making them weak, so they will break near the point rather than at the upper end of the twist, can only be questioned by those who claim there is no need of ever breaking them—which is good talk for agents and shop foremen, but hardly holds good in practice.

There are a variety of methods for holding drills in the machine, but no one seems to be near enough perfect to meet with universal approval. The taper shank is costly to make, and the drill cannot be held in anything but the chuck it is made to fit. The straight shank with set screw is seldom true, and grip fits and universal chucks are liable to slip.

Perhaps all plans have been tried, but I hope to be able to applaud the man who gets up something better.

The machines for driving drills are as various as can well be imagined, ranging from a bit-stock, turned by hand and forced up by the breast, through a similar device made stronger and turned by one man while the pressure is put on by a lever worked by another; then the fiddle-drill in which a string passed around a spool and fastened to an elastic bow is used to turned the drill—the ratchet-drill, the crank-drill, the geared crank-drill, the lever-drilling-machine, the post-drilling-machine, the girder-drilling and boring machine and the radial machine.

With all our modern perfected mach nery it seems useless to spend much time in describing such primitive devices as a fiddle-drill and lever-brace, and yet there are times when small holes are to be drilled in large castings, that it costs twice the time and money to move the work to the machine than to drill the hole, providing the workman had the tool and disposition to do it by hand. And, too, one is not always at the shop when accidents occur. This knowing what to do in times of difficulty—this knowing how to do jobs with the most primitive tools or extemporized contrivances—is just what makes the man of expedients so much more valuable than the one who knows only the one way.

In the construction of the fiddle-drill there should be a thread cut on the spool for the cord to work in to keep it from chafing. In the crank-drill for general purposes, the crank direct on the drill-spindle to work without the intervention of gearing is the best, though not so applicable to all positions as one driven with bevel gearing. Where there is gearing it would be an improvement if they were readily changeable to change the speed.

Of the score of ratchet-braces, that is the devices for working a drill by moving a lever back and forth, there are but few that seem to possess all the requirements desirable. If the ratchet teeth are coarse, there is too much lost motion; if the teeth are fine they wear out, break off, or the pawl soon gets so it will slip over. To overcome these objections the differential ratchet was invented, or rather patented, as no doubt it had been invented a dozen times before. This device consists in placing say three pawls equidistant around a ratchet with seven teeth. Only one of these pawls can engage at once; so while the teeth in the ratchet are strong, there being but seven, the ratchet cannot under any circumstances be turned backwards more than the twenty-first part of a circle before one or the other of the pawls wi l catch. This overcomes both of these difficulties, but leads to another, viz., complication, or at least a multiplication of parts. There have been a half dozen or more friction devices invented for the same purpose—the object sought being to produce a tool that there should be no lost motion whatever, and also one that would work silently. The noise of the ratchet is thought by some to be objectionable, but none of the devices have proved anything like a success. The most of the friction devices which work at all have more or less lost-motion—none of them are durable. The greater part of them fail to work in all positions, and as to doing away with the noise it could be done easily with an ordinary pawl if it were worth doing. The drill is forced up to the work by the screw at the back being rested against some temporary structure, or support. It is better to have this support elastic or yielding than rigid. For with a rigid support the screw must be set out at every revolution of the drill; whereas, if it is yielding, the drill may be revolved several times and the spring will keep to its cut. A chuck fitted to the ratchet-brace, so as to use the ordinary drills of the shop instead of having to have an extra set for that special tool, is economy.

A drill will stand to take a heavier cut when used by a ratchet-brace than it would be, either possible or policy, to use when run by the drilling-machine; the slow speed at which it is run does not generate heat enough to endanger the temper.

Our old ratchet-brace is a first-rate sample of a poor one, and the new one made by Lowell Wrench Company, of Worcester, is the best specimen of a good one that I have seen. You will notice that the ratchet is completely enclosed, which not only protects it, but serves as a bearing all around, and it ought not to wear out soon. The pawls are bedded in the solid metal of the handle, and it seems that nothing save a power sufficient to crush them could even do any harm.

(*To be continued.*)

PROMISES.—We beg to be informed promptly of the fact, in any instances where promises, expressed or implied, remain as yet wholly or partly unfulfilled by us. It is our intention and general practice to perform all and more than promised; but the hurry of the past season, and the extra amount of work entailed upon us by a business increasing more rapidly than it was possible to extend our facilities, have caused us in some cases to delay certain matters much longer than was pleasant—in some cases longer than profitable—to us; and in some few instances matters have been completely driven out of our minds. We beg now to announce that we are making arrangements by which we shall soon be at least up with our work, and if there are any back matters which have been crowded out of sight, we wish to be reminded of them, in order that we may give them our speedy attention.

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MATTER for publication in the REVIEW should reach us not later than *Tuesday noon* of the week in which it is intended to appear. When they come later than that, it is impossible to have creditable proof-reading, or to get the paper out in time for mailing on Friday morning.

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PAPER ON THE

GOVERNMENT SURVEYS FOR A SHIP CANAL ACROSS THE AMERICAN ISTHMUS.

BY COMMODORE AMMEN, CHIEF OF THE BUREAU OF NAVIGATION.

The American Geographical Society of New York has in press, for a very early issue, a special bulletin of the proceedings at its recent first session of the season held in Chickering Hall. The subject engrossing the chief attention of the Society, was an elaborate paper on the Government Explorations and Surveys for a Ship Canal across the American Isthmus; a paper addressed by Commodore Ammen, Chief of the Bureau of Navigation, Washington, to the Hon. Charles P. Daly, President of the Society, in reply to a request for information as to these surveys. In the absence of Judge Daly, through severe indisposition, the General Secretary of the Society, Mr. James T. Gardner, read the statement to a very large and attentive audience; pointing out the different surveys and projected routes for a canal upon an extensive map prepared for the purpose.

The presentation of the subject was opportune. The object stated by Commodore Ammen, was the correction of misconceptions in regard to this Government work, carried on during the last five years on the Isthmus, at much out lay and labor. Although several extended reports in quarto form have been published by Congress within this period, together with the less extended abstracts of the most recent work—on Panama and the Atrato routes (to be found in the Report of the Secretary of the Navy for 1875)—the public generally has not been aware of the long continued and persistent efforts on the part of government officers to determine, if possible, the practicability of a ship canal. Still less have these efforts been known and appreciated abroad; in proof of which may be cited the fact that a number of gentlemen, who came over to visit our Centennial, were found to be seeking information on the subject, and apparently under the idea that the American government had been almost wholly uninterested in it. Among these especially, M. Leon Drouillet, a member of the Geographical Society of Paris, brought with him a pamphlet containing a proposition for what he calls "A general and *serious* survey of the Isthmus," and inviting to this, international assistance. Unfortunately for the propositions of this pamphlet, M. Drouillet has treated in it the United States surveys as entitled to no higher character, or credit, than those which have been at different times set forth by the merest adventurers, who, never having penetrated the Isthmus, have been concerned only in the organization of stock companies or ephemeral concessions. It was therefore doubly seasonable at this time, when the Government work has been completed, to present a dignified statement of the labors of its officers; especially since an appeal was being made to the American Geographical Society to lend its influence for a survey, as though our government had accomplished nothing.

The paper presented to the Geographical Society very justly says: "In view, therefore, of the long series of elaborate explorations and reconnoissances lately made by the United States, reported upon by the Commodore to the President, and *accepted as satisfactory* by him, it seems proper to present what has been really done by us, and to leave to the good judgment of those societies and interested powers whatever action seems to them necessary or advisable.

After showing that for more than 50 years the United States has manifested a deep interest in the problem of an isthmus canal, and that a very warm personal interest has been felt and exercised by President Grant and the Navy Department, Commodore Ammen gives in brief the results of the several explorations on the Isthmus from north to south as follows:

I. Across Tehuantepec. An instrumental reconnoissance, made under the present Commodore Shufeldt, by Civil Engineer Fuertes, with a party of naval and civil officers, located a proposed line, from the head of ship navigation in the Coatzacoalcos to the Pacific coast; for which line, however, no estimate of cost was submitted. If financially practicable, it would have had the great advantage of being an eminently inland American and a defensible route; but its number of locks (one hundred and forty) and the want of proper water supply condemned the line.

II. Nicaragua; the length of canal requiring excavation being here but sixty-one miles, and the lake supply being confessedly more than ample, this route has been reported to the President by the Commission, consisting of the Chief of Engineers, U. S. A., the Superintendent of the Coast Survey, and the Chief of the Bureau of Navigation, as possessing greater advantages and fewer difficulties than any other. Plans for the restoration of the once fine harbor of Greytown have been made by the Army Engineers. The Nicaraguan Government is understood at Washington to accord its full co-operation by treaty, and by financial assistance to the extent of its ability.

III. Panama. A survey and location of the route from Navy Bay to Panama was reported in abstract to the Secretary of the Navy in 1875; the advantages and disadvantages of the line will be found in the report of that year. As regards this route, it is worth noting that an engineer so experienced and able as Mr. J. C. Trautwine, the Chief of the Panama Railroad in 1850, very recently gave, in the *Polytechnic Review*, his estimated cost of a ship canal on this line at the fearful sum of $300,000,000.

IV. From the Gulf of San Blas on the Atlantic to the Chepo or Bayanos River, is a route which has been long advocated, chiefly because between these points the tides from the two oceans approach each other more nearly than elsewhere. But the surveys of Selfridge and Lull have demonstrated that there is no practicable line even with a tunnel of eight miles.

V. From Caledonia Bay, the instrumental lines which were run on the north and on the south, westward, showed that no pass exists with an elevation less than from 1000 to 1200 feet.

Of the remaining projected routes, each of which has had for its starting point on this side some one of the mouths of the Atrato, the line advocated by Mr. De Puydt, who has most charmingly offered a canal with neither lock nor tunnel, was followed closely for a long distance, but only to reach an altitude of nearly 650 feet, with the mountains of the divide plainly visible before them. The next branch line, once strongly urged by Hellert, Lacharme and Gogorza, recently examined by Selfridge and Collins, developed a country consisting of a continuous network of high hills. It is this route—the Atrato via Cacarica and Paya Rivers—which is now being again examined by a Commission consisting, according to the *Panama Star and Herald*, of some fifteen foreign gentlemen appointed by the Civil International Society lately formed in Europe. M. Gogorza has brought them over under a contract with the New Granadian Government to find a Canal in this part of the Isthmus. Mr. J. C. Trautwine, before quoted, does not hesitate to predict for this party, utter disappointment.

The remaining lines by the Atrato branching off to the Pacific either by the Truando River or the Napipi after having been fully re-examined and reported upon to the Commission on the Canal question appointed some time ago by the President, have been condemned by them and thrown out of the problem. They all involve large expenditure at some one of the Atrato mouths, with all the risks inherent in a tropical country and insuperably objectionable, whether on the score of morasses, overflows of the river, or of tunnelling. It is very certain that these routes will not be again considered.

The problem of a Trans-Continental Canal, therefore, is certainly not fully solved. The report of the Commission referred to has been communicated to the President, but for some official reasons has not been as yet communicated to Congress or printed.

We must wait for its issue and for the report of the foreign gentlemen now on the Isthmus in search of their canal.

EARTH-EATING. (GEOPHAGISM.)

So many incidental allusions are made from time to time concerning the curious habit of earth-eating which obtains among divers peoples, that a few remarks on this topic may not be without interest.

The fact has long been recognized, that the presence of mineral substances in food is indispensable for the proper nourishment of the body. This is more especially true of the phosphate of lime, which is the chief constituent of the bones; but is nevertheless a fact of such general significance, that it may safely be said that food which is destitute of, or very poor, in mineral constituents, is not competent to support life.

In view of this fact, therefore, geophagism, as the earth-eating habit may be called, must possibly be regarded not altogether as the gratification of a depraved or vitiated taste among barbarous peoples, but partly as one of the results of the imperative demand of the system for mineral nutriment.

We find the habit developed quite largely, for example among the native inhabitants of the tropical countries, who subsist almost exclusively on sweet and watery fruits, and but to a trifling extent on cereals and fish, and in such cases may reasonably infer that the dearth of mineral matter in this species of food created the demand for it. In other cases, sheer necessity, as, for instance, a general famine, has driven men to still the cravings of hunger with this filling but not satisfying substitute. In others again, the habit would appear to be purely the gratification of a vitiated taste, as is the case, for example, with certain people, who add earthy minerals to their food. This habit is affirmed to be practised to some extent by the Laplanders. It is also declared that quarrymen in many parts of Würtemburg are in the habit of eating a smooth, unctuous clay that occurs in the fissures of the rocks, and which they call by the curious name of *mondschmalz*. Similarly, Vogel reports that the quarrymen of the Kyffhausserberg, in Thuringia, have the habit of spreading on their bread, and eating with apparent relish, an unctuous clay, which they call *steinbutter*. The earth-eating habit, as Tiedemann first reported, and as subsequent writers have substantiated, is quite pronounced among the native tribes inhabiting the shores of the Amazon. The same habit has been observed among the Ottomacks in Guiana and the natives of

Martinique, and Guadaloupe. To the list of earth-eating peoples, the Javanese must likewise be reckoned. Prof. Fuchs, indeed, reports that the earth is formed into thin cakes having a diameter of from 1 to 1½ inches, dried over an open fire, and brought into the market as an article of sale.

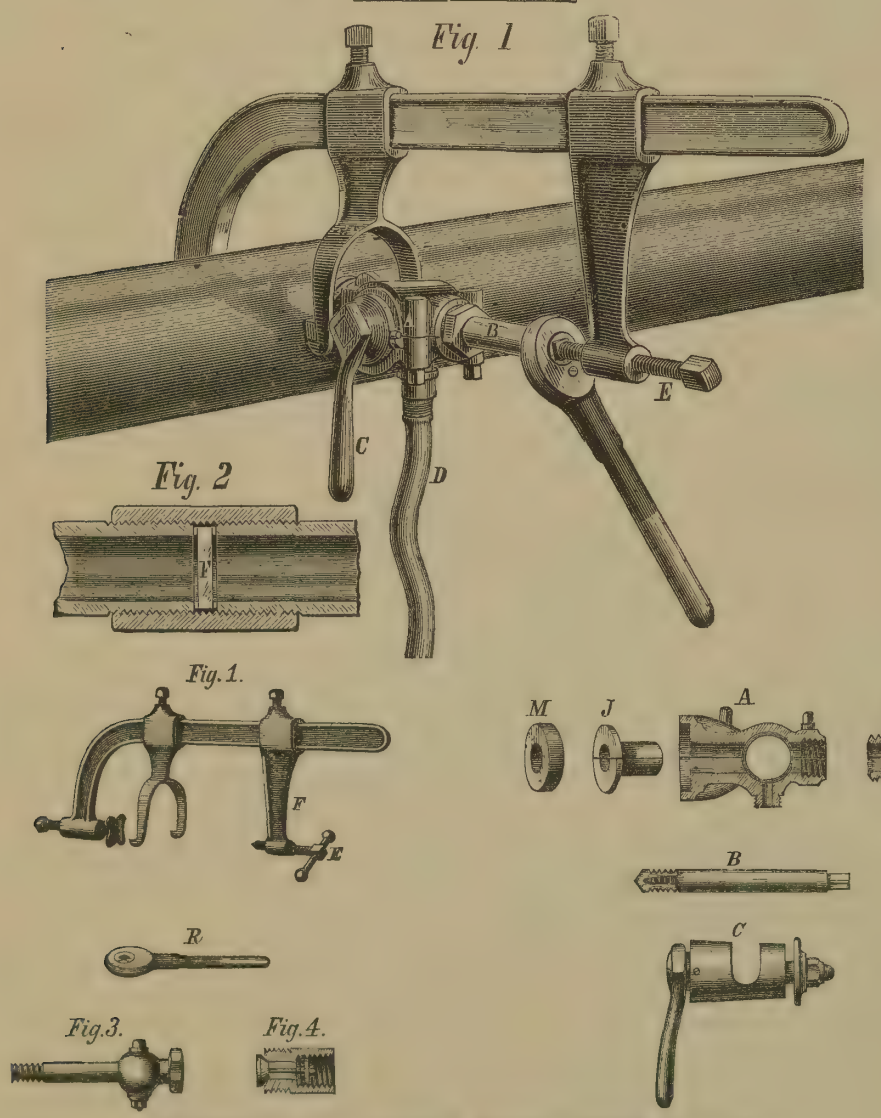
The analysis of this particular earth showed that it was a clay rich in iron. It is perfectly smooth to the touch, and placed upon the tongue, not the slightest grittiness is perceptible. The edible earth of the dwellers of the Amazon is said to be a species of infusorial earth; while that of other South American natives, according to Tiedemann, is a clay. He narrates, for example, that the indian women of the Magdalena river, when engaged in fashioning earthen vessels of this material, constantly carry their fingers to the mouth, seeming to relish heartily the clay attached to them. The natives of the Province of Parana, he also states, dig from the earth a species of clay having an agreeable odor, which they fashion into shallow cups as thin as card-board. They are used for drinking cups, the clay seeming to impart to the water a peculiarly pleasant taste, after drinking which, the cup is eaten. In Chili, a similar custom is reported to obtain, and likewise in Portugal, in the Province of Estramos, where the clay is made into Bucaros or Barros, which are said to be esteemed by the ladies as a delicacy.

It is a matter of common knowledge that many of the "poor whites" in our Southern States, eat a certain kind of blue earth so constantly, and in such large quantities, as to distend the abdomen permanently and impart a sallow and unhealthy appearance to the complexion.

The Swedish peasantry, according to Berzelius, were accustomed to consume hundreds of wagon loads of the famous deposit of infusorial earth at Lüneburg, not from any dearth of nourishing food, but from choice; and the siliceous earth of Finland, we are credibly told, is mixed by the peasantry with the flour in the making of bread.

We add herewith the analysis of samples of earth used for this purpose, from two separate localities, which while they indicate quite a difference in composition, are alike in being quite destitute of any value as a nutriment, viz—

(I.) FUCHS.		(II.) VOGEL.	
Silica	50·63 per cent.	Carbonate of Lime	23.5 per cent.
Alumina	21·32 "	do Magnesia	68.7 "
Oxyde of Iron	10·47 "	Magnesia	2·9 "
Lime	2·40 "	Alkalies	1.9 "
Magnesia	0·33 "	Water	2.8 "
Alkalies	1.25 "		
Water	12.97 "		



YOUNG'S WATER AND GAS MAIN TAPPING MACHINE.

MADE BY WM. YOUNG, EASTON, PA.

This machine is for the purpose of tapping water-mains and attaching service pipes thereto while the full pressure of water is on. With it the main pipe is drilled and tapped, the service-pipe screwed in, and connection made in one operation, without shutting off the water or changing tools. It should prove a valuable tool for water companies, gas companies, and plumbers.

Fig. 1 represents the machine attached to the main, ready to commence operation. The two parts of the drill case, A, are united by bolts, and receive the tap, B. At the end nearest the pipe a socket is formed to receive a packing gasket, in order to make a water-tight joint. The handle, C, communicates with a cock within, to close the apparatus when the drill is removed, the cock having a notch to allow of the passage of the drill. Bushings in the drill case fit different sized taps. Lugs project on outside of socket end of drill case, so that drill case can be clamped to main, as shown in engraving. The hose at D serves to conduct chips away. The combined drill and tap, B, is operated by the ratchet, R, and fed by the screw, E. The machine is clamped to the main, as shown in engraving. The hole is drilled and tapped at one operation. The tap is then drawn back, the handle, C, drawn to the front and tap removed; the orifice is thus closed ready to re-open and force connection into the main.

The stuffing box on the outside of the drill case makes a water-tight joint around the connection while being forced in through the machine. The main bar, arm, and screws are of cast steel; the body of the machine of brass, thus making it strong and durable. For the purpose of making connection it is optional to use either of the following devices:

1st. The device marked Fig. 2 in the engraving, by means of which the water is kept from passing through the connection by the glass disk marked F, with rubber washer on each side, as shown, and between the ends of the sections of service pipe, they being joined by a common socket. After the connection is made a few turns of the outer pipe crushes the glass, and the pieces are washed away, allowing a free passage to the water. This device was patented April 1st, 1873, and is sometimes used to avoid the expense of a stop cock near the main.

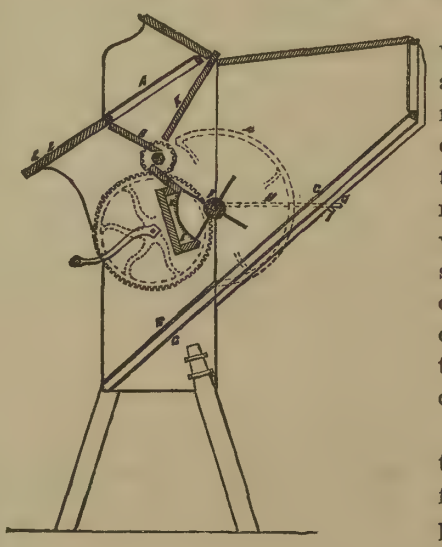
2d. A brass stop cock, Fig. 3, made with the stem long enough to reach through the machine, the cock itself remaining outside. The outer end being threaded for iron service-pipe, or a coupling screwed on for lead pipe.

3d. A common brass stop cock, the stem portion being a section of iron service-pipe.

4th. The self-closing brass valve marked Fig. 4. This device is a brass socket that screws into the main, with a valve inside, and so arranged that the pressure of water keeps it closed until the service-pipe being screwed in opens it. To make new connections at any time, all that is needed is to unscrew and remove old pipe and replace with new—the valve is self-acting. This should be a very valuable improvement, as it takes the place of the cock, is less costly, does not project from the main much farther than common plugs, and will answer equally well for lead or iron pipe connections.

PATENTS.—We are frequently asked if we obtain patents. We never did, do not now, and do not expect ever to do so. If we were to act both as journalists and as patent agents, we should be very apt to neglect one or both avocations; besides seriously affecting the value of the REVIEW as a reliable scientific journal. As our prospectus truly says, "we have no entangling alliances."

SAND AND GRAVEL SEPARATOR.



This invention is claimed to screen sand with greater rapidity, wet or dry, than by any other way, and to screen sand, no matter how wet, when it cannot be screened by any other process. It separates the gravel from the sand and deposits the roofing gravel, and coarse gravel for walks, &c., in separate places from the sand, thus saving the necessity of a second screening when roofing gravel is in demand. The makers state that one man to throw the sand and a boy to turn the crank can screen thirty yards a day.

A is a coarse screen where the sand is thrown in, and which keeps large pieces from passing into the machine. The sand passes down to the feeder B, which carries it down to the cylinder F, which is made with four rows of pins, and which revolves with velocity, spreading and separating the sand and gravel and throwing it against the screens G G, which being two screens, one over the other, the roofing gravel and sand passes through the upper screen, (which is made half inch mesh or any other size needed) to the lower which is six meshes to the inch or any size required. The roofing gravel passes down between the legs, which are enclosed; and the sand through the fine screen. The coarse gravel passes down in front of the machine. H is a rapper or beater which strikes eight times with every revolution of the crank against the under part of the screens and loosens any sand that may stick to the screen. K is a feed board which can be raised or lowered to regulate the flow of sand to the machine. L is a shelf for carrying off coarse gravel.

The machine is made by Chambers & Quinlan, Decatur, Illinois.

RETRIBUTION.—The individual who sent us a two-column notice of his wonderful invention or manufacture (scrupulously omitting any intelligible description thereof), to "aid us in the Loudible disire of Improving scienc Ass aplyde to the usefull Arts;" and wound up with permission for us to mention that this machine "receaved the onely meddle of the Centenial Bord of Juges"—has had about seven inches of his ears torn off by getting them caught in a belt.

LUDLOW'S FIRE HYDRANT.

Fig. 1

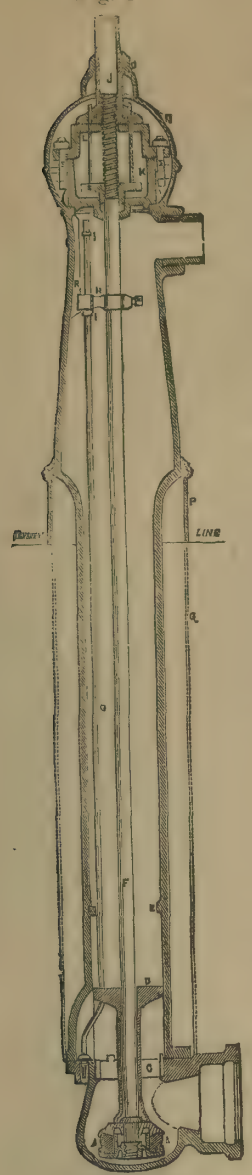
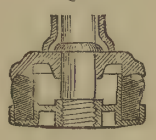


Fig. 2.

The cuts represent a new style of Fire Hydrant, made by the Ludlow Valve Manufacturing Co., Troy, N. Y. Fig 3 is an enlarged view of the gate as now made.

A A is a rubber ring compressed between two metal plates, B B. C is a brass ring or seat, screwed into the iron bottom. D is a tube or sheath with two projecting arms. E E are projections on the inside of the hydrant stand-pipe. The valve rod, F, passes freely through the tube, D, and through the upper plate B, and is screwed into the lower plate B. The hydrant as shown is open. On turning the hollow top nut, J, the valve rod, F, rises, carrying with it the gate and sheath. When the gate reaches its proper position inside the ring, C, the arms, D, strike the projections, E E, arresting the upward movement of the top plate B, while the lower plate B continues to move up, squeezing and expanding the rubber forcibly against the ring, C, and completely stopping the passage of the water. G is a waste rod with fluted brass conical valve at its lower end. H is an arm fastened firmly to the valve rod, F. One end of this arm runs in the groove or guide, R, thus preventing the valve rod from turning on its axis. The waste rod passes freely through this arm. As the main valve closes, H strikes nut I, lifting the waste valve. As soon as the main valve commences to open the waste valve closes. It cannot get out of the waste hole, but moves loosely in it, thus preventing the hole from being obstructed.

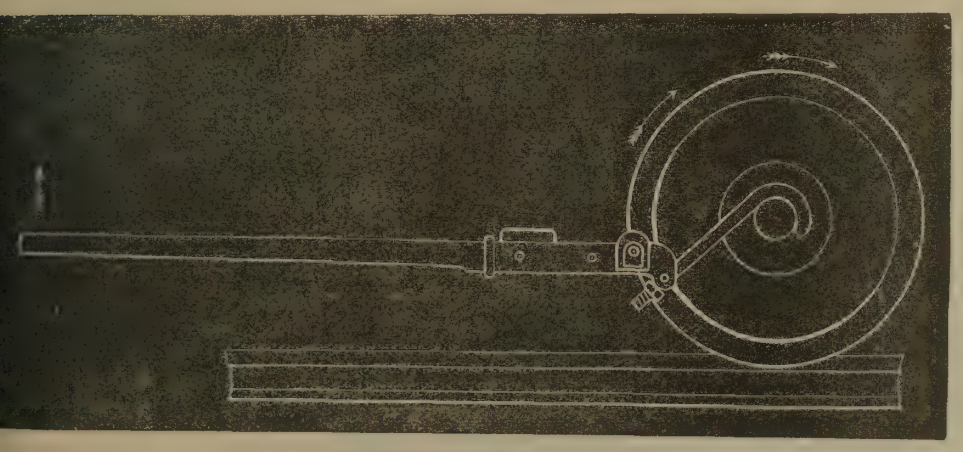
Fig. 3.



The valves and seat can be easily removed from this hydrant without digging. To accomplish this, unscrew the hollow nut, O, take off the cap or dome, N, remove the nuts from the two bolts, M M, separate the nut, J, from rod, F, when the top plate, K, can be lifted off and the valves taken out.

By means of a wrench adapted to the purpose, the seat ring, C, can be unscrewed and taken out. Scratching or marring the seat should not, however, cause a leak, as the rubber should adapt itself to any inequality in the surface. Should the rubber become damaged, it can be easily replaced without fitting. Frost cases may be attached when needed.

CURRENT NOTES.—Those sending fractional currency for sample copies need not go to any trouble to find torn, ragged, or counterfeit notes to mail us. We can pass off clean, whole, and genuine notes without difficulty.

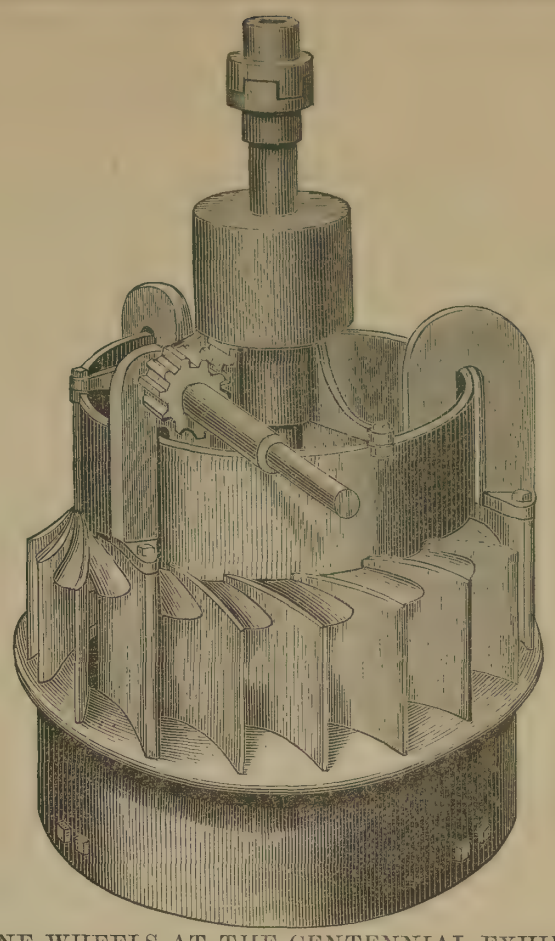


HESHUYSEN'S CAR SHIFTER.

The above cut shows a handy device for shifting cars. It is a lever of the second class, fulcrumed on the axle; the short arm being jointed to admit of a great purchase being taken, and adjustable in length by means of a nut and screw, to adapt it to wheels of various diameters.

BIAS—sometimes written *buy us*—has a wonderful influence at times, especially as regards endorsements and descriptions of inventions and processes. This journal has no entangling alliances, and is free from bias.

THE INDEX AND TITLE PAGES for Vols. I and II are in course of preparation and will appear with our next issue.



TURBINE WHEELS AT THE CENTENNIAL EXHIBITION.

VI.

THE RISDON TURBINE.

This turbine has several very marked points of peculiarity, with some striking departures, in construction, from the usual form of turbine. It is shown in the cut in its most improved state. The chutes occupy the whole space around the circumference of wheel, and formed by thin blades, so that the water is furnished in nearly a solid body, and free from the objectionable vacuous cavities. The guides are fixed only at the bottom, to the crown piece forming the lower limits of chutes. The upper crown, or chute limits, consist of segmental pieces, or wings just fitting between the guide blades and attached to the gate cylinder, rising and falling with it. When the gate is closed, the upper and lower chute limits, or crown rims, come in contact at the gate-joint inside; and from this outward the two diverge from each other, so as to give a high degree of flare.

By this arrangement a perfect chute is formed for all openings of gate, taking the form of a rapidly converging adjutage for all sides, a form very favorable for velocity of projection of water.

The turbine is represented with the gate fully open; the cylindrical shell appearing at the top of the figure being the upper part of the gate cylinder. This cylinder is carried on a spider, the arms of which are also seen. The hub of the spider extends upward, having a circular plate, or piston, fitting in the inverted cylinder shown uppermost in the cut, and closely fitting the shaft. The space above the piston in this cylinder communicates, by an opening down the wheel case, with the vent of wheel, so that any slight leakage on the part of the piston may escape. This arrangement, it is readily seen, is made by the pressure of the water to exert a lifting power to balance the weight of gate, and also the downward action of the water upon the upper crown segments and attached to the gate. The rack attached to the spider and pinion then easily control the gate.

The three "goose-necks" shown in the figure, support the cover of the wheel, which is turned so as to lie close to the gate shell. This joint is rendered water-tight by leather packing. The shell being also turned, and sitting down upon a turned seat when closed, a gate closure is secured which is exceedingly free from leak.

But the boldest departure from ordinary practice is found in the wheel itself; and it is regretted that we have no cuts to fairly represent it. It has a much greater depth than most turbine wheels, receiving the water horizontally, and, as it were, discharging it vertically downward, at a story below. Thus the floats form a sort of quarter-turn conduits, as regards the meridianal section; and besides, they turn away from the water, at entrance, and at exit back nearly in the usual way. The first part of the float is nearly vertical, and would appear turned from the water as viewed in horizontal projection. The great wonder to a foundryman is that a body of such extraordinary form as this wheel can be cast in one piece.

This turning of the floats away from the water is greatly at variance with the form that would be adopted by those who believe the water must act by impact or percussion alone. This, taken in connection with the fact that the chutes are of good form, may account for the remarkably high percentage of 90 to 93 per cent. which this value is said to yield.

The wheel is built at the T. H. Risdon, Tyler & Co's Works, at Mount Holly, N. J.

School of Mech. Eng.,
Ill. Industrial University.

S. W. ROBINSON.

☞The illustrated description of MR. MAXIM'S Automatic Fire Apparatus, (referred to in our last issue, and publication of which was promised for this week's REVIEW), is delayed until next week, on account of the late arrival of the drawings from our New York office.

PROGRESS IN SCIENCE AND THE ARTS

ENGINEERING—CIVIL, MECHANICAL, &c.

Corrosion of Boilers results on the exterior surface from the following causes:—

I. Careless setting in too much lime; setting on damp foundation; cold wet ashes having been allowed to remain too long in contact with them; soot in tubes becoming charged with pyroligneous acid, or retaining fine dust of ashes, and consequently sulphur acids derived from pyrites. The above causes suggest their own remedies—care in preparing and completing the setting; in cleaning flues and ash pits, and in firing.

II. The use of brass connections directly on the shell—especially where there is a little leakage.

Interior corrosion is more apt to take place:

I. In land boilers fed with *pure* natural water. Where lime salts are present, there is formed a crust preserving from corrosion, although having special inconveniences. Highly chalybeate waters deposit no crust, but do not seem to corrode—save in a single case of incrustation cited, where it is likely that there was some material in, or adhering to, the crust, which suffered decomposition on contact with the heated iron, and hence attacked the metal. This is the case with crusts formed with fat or greasy substances.

II. In marine boilers, we have a variety of corrosive actions, according as the water used is (nominally) entirely fresh, or contains a proportion of sea-water.

The Rowan & Horton, and the Perkins systems, are the only ones using exclusively fresh water in regular working. It has been occasionally attempted with ordinary boilers supplying compound engines; but the results were quickly disastrous. Where sea voyages are made, boilers are liable to receive salt water through imperfect surface condenser joints; hence it is doubtful whether the intention to use entirely fresh water has been actually carried out. Intermittent corrosion from decomposition of fat acids, and from galvanic action, may be neutralized—the first, by filtering the feed-water and neutralizing any free acid by zinc; and the second cause also was removed by means of the filter, it being in general caused by local contact with particles of metals carried into the boiler; and not by means of "the surface condenser and the battery forming two elements of a huge battery, the steam and water being the excitant."

Even in the Perkins system there should be some corrosion, caused by the gases of the natural fresh waters, and by air occluded in the air pump.

Where the water used is partly fresh and partly salt—as is the case with the most numerous and worst corroded class—some remarkable statements and suggestions are made by different authors:—as that continuous re-boiling increases the corrosive power of water, etc.—whereas, boiling causes deaëration and consequent loss of corrosive power. Thus the remedy proposed by some—the aëration of the condensed steam—would but *increase* the corrosive action.

"There is no case known in which the proper effects due to the employment of distilled water alone, and free from gases, could have been observed." The liberation of carbonic and hydrochloric acids are proved; and their action and that of decomposed chlorides, under high pressure and temperature, would account for most of the corrosion which occurs. Greasy matters are shown to wield a great power for evil. The explanation of the fact that all these corroding agents have done damage principally since the surface condenser was used—is that this has reduced the proportion of sea water below that required to form a protecting scale; and also provides for the liberation, by repeated boiling, of the carbonic acid held by the sea-water. Sea-water alone at the boiling point corrodes iron. A small quantity of sea-water is capable of doing mischief where a large quantity is not. Pitting and blotching are due to non-homogeneity of metal, and to differences of heat.

The use of zinc will not do where any proportion of sea-water is used; it is recommended for nuetralizing free acid in fresh water. Filtering the feed is an excellent precaution. The formation of an artificial scale or coating of calcium sulphate and magnesium hydrates (in proportion varying with the boiler pressure) is recommended. [*Abr. from paper on Corrosion of Boilers, read before the Brit. Ass'n. at Glasgow, by Mr. F. J. Rowan.*]

The Regulation of the Tiber.—The committee of 11 appointed in 1871 has reported, eliminating all the submitted propositions except two: (1) the deviation and regulation of the bed of the river within and beyond the city limits, and the execution of canals and aqueducts; (2) the erection of embankments and the formation of sewers to receive the city sewage and discharge it into the river at a convenient place beyond the walls. The committee examined and reported upon 19 projects—classifying them into four groups:

(1.) Improvements of that portion flowing within the city, and construction of locks and overflows at the mouth of the principal confluents. Cost, $5,000,000.

(2.) Deviation of the river outside the walls of Rome, by forming a new channel; leaving only a certain quantity to flow through a canal in the city, with a given velocity. This proposition was made by Gen. Garibaldi (estimate, $11,600,000) and modified by Amenduni, Amadei, and others.

(3.) Construction of a relieving canal, through which the water could be discharged; and of Tiber regulation works from Sassi di San Giuliano to the basilica of San Paolo. $12,000,000.

(4.) Improvement of that part within the city, and construction of embankments and sewers, as proposed by the committee of 1871. Cost, $6,500,000.

The commission recommended (Nov. 25, 1875) to the Superior Council the last named plan. The Council rejected the first and second plans and approved the last. The Minister of Public Works desired the second (or Garibaldi scheme), and made surveys, estimates, and plans therefor. Amenduni's report made as estimate for the diversion $16,800,000; for the canal through the city, $12,400,000. Amadei, Filopanti, Guestiniani, and others, made similar examinations and reports, showing that dangers from floods would not be done away with by the embankment system.

The Superior Council, after many meetings, desired to construct earth-works to receive the flood-waters and prevent inundation outside the city; and quay-walls within the city, of a hight determined by the Lungo Tevere road. The width of the new river-bed should be 328 feet, maintained nearly to the Civito Vecchia railway bridge. Signor Vescovali's drawings are adopted for the most part. At the Tiberina Island, it is immaterial whether Canevari's plan of suppressing one branch be adopted, or Vescovali's cheaper plan of maintaining both. The latter also proposes to widen the right branch here, 32 feet. Carnevari recommends the enlargement of one arch of the St. Angelo bridge. Vescovali states that this bridge causes no backing up during floods; although the others do. But the Council thinks that when the flood-water is all passed through the arches (instead of finding its way around, through the streets), there will be backing up; and recommends the enlargement of one arch at each end. The Rotto bridge should be destroyed. If the Cestio and Fabricio bridges at Tiberina Island, the older and more valuable could be retained, and the others removed, as proposed by Carnevari. The Sisto bridge may be retained, the river-bed being cleaned of rubbish; and the waterway being increased 50 per cent. The river-bed should have a slope of 1 in 2,500. [*Abr. from Engineering*, xxii, 479.]

The Welland Canal enlargements will be completed in 1878. The width will be 190 feet at top and 100 at bottom; depth, 14 feet.

A City heated by Steam.—It is stated that an effort is on foot to heat the city of Lockport, N. Y., by steam-pipes. We predict the failure of any such scheme—the heating of cities by gas, at an early date, is vastly more probable.

Egerton's Tidal Pier has floating dummies, 80 feet apart, increasing in size as they get farther from the shore, and thus bearing the weight of the bridge proportionately and substituting for a huge girder construction a number of small girder bridges. The supports are made to rise and fall through only a proportion of the tidal rise and fall; a series of "lazy tongs" being used. [Abridged from *The Engineer*, xlii, 394, (illus.)]

Waterworks in Ceylon.—The town of Kandy is to have a reservoir of 8 acres (containing 39,000,000 gals. or 3 months' supply), formed by damming a valley by an embankment 180 ft. in length (at summit), 45 ft. high, and 32 ft. wide at base; with storm channel having sectional area of 56¼ ft., capable of discharging 75,000 gals. per minute. There are to be two filtering beds, or reservoirs, each of the latter holding 670,000 gals., or 2½ days' consumption. The town has about 10,000 inhabitants. [Abridged from *The Engineer*, xlii, 395.

A Novel Tube Expander, the invention of Mr. T. J. Lovegrove, was exhibited and described at the November meeting of the Franklin Institute, and is an ingenious device for utilizing the elasticity and incompressibility of india rubber. The expander is described to consist of a ring or collar of india rubber fitting closely upon a bolt of iron, and secured between two disks inserted in the ends of the tubes to be set or expanded, and held or clamped firmly in place. This collar is then compressed in the direction of its length, by means of a screw on the bolt, which moves one of the disks, and the effect of this endwise compression is to expand the rubber ring radially, producing consequently a great pressure on the inside of the end of the tube, proportionate, and almost equal in amount to the endwise pressure exerted by the action of the screw. This result is caused by the fact that rubber, while being highly elastic, is almost, if not quite, perfectly non-compressible, and is sufficiently tenacious not to flow away at the joint between the disks and the inside of the tube.

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Spongy Platinum.—The production of spongy platinum, says the *Metallarbeiter*, is a task more easy in appearance than reality. The principal requirement of spongy platinum is that it should be spongy, but this obvious requirement is very frequently overlooked, and hard and useless masses of platinum are produced through overheating the sponge and running together the finer particles. Into a concentrated solution of muriate of ammonia drop a similar solution of platinum chloride; a yellow precipitate is formed, which is washed three or four times in hot water to free it from the sal ammoniac. This precipitate, when properly cleaned, and while still moist, is dropped on a very thin platinum wire stretched several times across a small ring of copper, and is then allowed to dry thoroughly. After drying it is slightly heated over a spirit lamp, contact with the flame of which is to be avoided. As above remarked, only very careful heating over the spirit lamp will give satisfactory results.

The Imagination in Science.—From the *Scientific American* we glean the following:—

The correspondence between the hypothetical element eka-aluminum, imagined by the Russian chemist Mendeljeef, and the real element gallium, recently discovered by M. Lecoq de Boisbaudran, is so remarkable that the attention of European scientists is now being closely devoted to its examination. In 1869, Mendeljeef published a memoir, which attracted little notice at the time, but which announced as a law "that the properties of simple bodies, the constitution of their combinations, as well as the properties of the latter, are periodic functions of the atomic weights of the elements." At the the present time, M. Lecoq de Boisbaudran has succeeded in preparing 7·5 grains of gallium. In a liquid state, gallium, the fusing point of which appears definitely to be 86·27 deg. Fah., is of a fine silver whiteness; but on crystallising, it takes a more marked bluish tint, and its brilliancy notably diminishes. By suitable cooling of the melted material, isolated crystals are obtained, in octahedral shape, and these M. de Boisbaudran is now measuring. As regards density, which is the important point to be noted, M. de Boisbaudran says: "In May, 1876, I attempted to measure the density of gallium by a specimen weighing 0·92 grain. I obtained 4·7 at 59 deg. Fah., and relatively to water at the same temperature. The mean of the densities of aluminum and of indium being 4·8 to 5·1, the specific gravity provisionally found for gallium appeared to accord quite well with the theory placing the metal between indium and aluminum. The calculations established by M. Mendeljeef, however, for a hypothetical body which appears to correspond with gallium, show the number 5·9. Gallium, crystallised under water, sometimes decrepitates on heating. Perhaps my first metal contained bubbles filled with air or water. To eliminate this possibility of error, I heated the metal highly and solidified it in a dry atmosphere. Then I obtained higher densities, varying from 5·5 to 6·2, the weight of the pieces tested being some tenths of a grain. Finally I combined six specimens, aggregating 8·7 grains." The mean of two different experiments gave (1) 0·5935; (2) 0·5956. "It is hardly necessary to insist," adds the author, "upon the extreme importance which attaches to the confirmation of the views of M. Mendeljeef concerning the density of the new element." According to t *Scientific American*, this, however, is by no means all Seven years ago, M. Mendeljeef said "eka-aluminum will have an oxide of the form El_2O_3. The oxide of gallium is Ga_2O_3. "It will be almost fixed, and will melt at a very low temperature." This answers exactly to gallium, which melts at 86 deg. He said further, that the future element, volatile and taking its place between indium and aluminum, would be discovered by spectral analysis, and so gallium was discovered.

In Lighting Fires in Stoves likely to smoke, first warm the chimney or its contents by burning a handful of shavings or paper *on top* of the coal.

The Manufacture of Illuminating Oil from Wood has become a large and successful industry in Sweden. The roots and stumps of trees are employed for the purpose. The wood is subjected to dry distillation, with exclusion of air, and a variety of products are formed which are of value in the arts. Among these may be mentioned turpentine, creosote, tar, acetic acid, charcoal, oil of tar and oil of wood. The wood oil cannot be burned in an ordinary lamp, but a camphene lamp can easily be adapted for the purpose. It is not explosive and is remarkably cheap. The pine tree is the best adapted for distillation, and there are 15 establishments in operation in Sweden, three of which produce 15,000 liters (887 gallons) of oil annually.

Glycerin as a Lubricant.—Chemically pure glycerin, free from water, is recommended as a lubricant for small machines and machinery parts, where common oils and fats turn acid or hard, and so clog or smear. Glycerin is of particular suitability for sewing machines, as any accident with it is of less consequence than with oils which soon become dirty. [*Iron* viii, 750.]

Imitation Nickel Plating.—As nickelizing is replacing silvering in some cases, so there are some where nickelizing may be itself replaced for many articles of small value, such as pins, particularly if they contain copper. The manipulation is very simple. Coarse rasped or granulated zinc is boiled for some time in a mixture of three parts by weight of sal ammoniac and ten of water, the objects immersed and stirred up with a zinc rod. The deposit is silvery bright, and resists mechanical action as well as a coating of nickel. The process can be recommended for goods which are meant for a second coating of some other metal, since any other is easily deposited upon zinc. [*Iron* viii, 750.]

A Station Indicator, for use in passenger cars, patented by Conrad Jenson, of Boston, has been adopted by the Fitchburg road. It consists of tablets, about eighteen by six inches, bearing the names of the different stations, each tablet arranged in the order of stopping. They are mounted on a sliding hinge, made of thick wire, and fold up something like a book, and are held in place by a lever, which is the key of the whole arrangement. Connected with that part of the lever nearest the tablets, are two flat pieces of metal, each a little over an inch in length, one an eighth of an inch inside the other, and both extending in the form of an angle, instead of running perpendicular to one another. Directly above this with the lever is connected the cord, which runs through a tube the length of the car, and so connected on the rear as to be worked from the platform, if necessary.

MISCELLANEOUS.

The Indian Cyclone.—Further details received regarding the cyclone of October 31 prove it to have been one of the most terrible calamities on record. Estimates based on official returns from each police section put the loss of life in the districts of Backergunge, Noakholly, and Chittagong at not less than 215,000. Three large islands—Dakhin Shahabazpore, Hattiah, and Sundeep—and numerous small islands were entirely submerged by the storm-wave, and also the mainland for five or six miles inland. These islands are all situated in or near the estuary of the the Meghna, a river formed by the confluence of the Ganges and Brahmapootra rivers, Up to 11 p. m. on the night of the catastrophe there were no signs of danger, but before midnight the storm-wave swept over the islands to the a depth in places of twenty feet, surprising people in their beds. The country is perfectly flat, and, therefore, trees were the only secure range. Almost every one perished who failed in reaching trees. A strange fact about the disaster is that in Dakhin Shahabazpore and Hattiah most of the damage was done by the storm-wave from the north sweeping down the Meghna. Several theories, the *Times* Calcutta correspondent states, have been started to account for this. One is that the cyclone, formed in the bay, struck the shore first near Chittagong, and went north for some distance, and turned southward again. Another is that the wind blew back the waters of the Meghna, which rebounded with terrific force when the pressure relaxed. A third supposttion is that there were two parallel storms with a centre of calm between them. The first or third theory seems most probable, as in Sundeep and Chittagong the destruction came from the south. [*Nature* xv, 89.]

The New Route from Europe to China.—The Baltimore *Sun* says: Should further explorations of the route from Europe to China, via the Arctic Ocean and the Yenesei River, across Siberia, as laid down by Prof. Nordenskjold, of Sweden, prove its entire practicability, a great stride will have been made both in commercial and in geographical science. The distance from England to Volgino, at the mouth of the Yenesei River, is about 3,900 miles, and from Volgino to Pekin, in a direct line, about 3,000 more. The present route from England to Pekin, via the Mediterrancan Sea and Suez Canal, is about 12,000 miles. The Yenesei River has its source in the Altai Mountains, which forms the boundary between China and Russian Siberia. It flows almost due north into the sea of Kara, which is distinguished from the waters of the Arctic Ocean merely by the islands Nova Zembla and the capes of the main land, which appear to partially inclose it. The distance between the head-waters of the Yenesei and the sources of the Amoor river, which flows into the Gulf of Tartary and the Japan Sea, is about 150 miles. The navigation of these rivers would have to be done by light draft steamers, while the short overland route of 150 miles might soon be "all rail" and resonant with fast trains. As the route lies through Russian territory, that country, of course, is master of the situation. At present a large proportion of the Russian and China tea trade is carried on overland by caravans, which the new route, if developed as suggestea, would render obsolete. In a political point of view the proposed route is of much importance in its bearing upon the Russian and English possessions in the distant east, and may introduce new sources of trouble between those powerful rivals.

The Earth's Internal Heat.—The theory that our earth is hot inside, is being attacked from several quarters; but it must be conceded that the grounds of attack are very slender indeed. The principal ground is that the temperature is not always found to steadily increase with the depth; thus, for instance, Mohr comments on the fact that in the deep artesian well of Sperenberg, near Berlin, the increase in temperature is not constant, but less at greater depths; and he comes to the conclusion that at the depth of one mile the increase ceases, and no greater heat is found further on. He mentions also that in the artesian well of Grenelle, Paris, a similar condition of affairs is observed; but he forgets that by the unequal constitution of the earth's crust the increase in temperature varies for different localities; sometimes it is 1° Fah. for every 30 feet, sometimes for every 50, 70, or even 100 feet; sometimes it increases at a greater rate when going down, sometimes at a lesser, and the observations of the latter fact are altogether too few to authorize any generalizations. Then he overlooks the fact that the 200 active volcanoes distributed over our earth's surface communicate to far deeper regions than only one mile, and bring from there the specimens of the material inside and of its temperature, in the melted lava they eject. It is surprising, indeed, that in view of such powerful testimony as the 200 volcanoes and their ejections, any savant can attach the least importance to the temperature observed in only two wells, which in any case, even for the deepest, penetrates only an insignificant portion of the upper layer of the earth's crust—at most, only the twenty-thousandth part of the earth's diameter. The fact is, we know nothing of the interior of the earth, and will perhaps never know, because it is utterly out of the reach of direct observation. Our only knowledge originates from the coördination of observations and the legitimate deductions, and if we compare the strong basis of the theory of a hot interior with the feeble basis of the opposite theory, the conclusions are altogether in favor of the former.

All that we can allow to the antagonists of a hot interior is that the crust is not so thin as some philosophers would make it, and that it varies enormously in different localities.

It is certainly very thick where mountain masses, such as the Rocky Mountains or the Himalayas, have to be supported, and probably strongly braced below by solid rock. Perhaps also the hot liquefied interior matter, such as is often poured out in enormous amounts by volcanoes, is not present in one single mass, but distributed in irregular pockets, separated by equally irregular partitions of solidified rock of a high fusing point. The latter hypothesis we think the most probable. [*Manuf. and Builder* viii, 278.]

Population of the World.—According to Behm and Wagner's just published Yearly Review of the Population of the Earth, the total population of the globe amounts to 1,423,917,000. Of this number Europe claims 309,178,300; Asia, 824,548,500; Africa, 199,921,600; Australia and Polynesia, 4,748,600; and America, 85,519,800. The average density of population of the whole globe is about 28 inhabitants to one square mile of land surface. The density is of course greatest in Europe, where it is 82 per square mile; in Asia, 48; in Africa, 18; in America, 5½; and in Australia and Polynesia, about 1½. The publication is accompanied by two maps, one showing density of population in India, and the other recent changes in the boundaries of various districts and countries. [*Nature* xv, 127.]

The Paris Exposition.—The refusal of the German empire to officially recognize the French Exposition of 1877 has not, as was at first supposed, any political significance. It is much more likely that the severe criticisms bestowed upon the German exhibit at the Centennial have shown the manufacturers of that country that they are behind the rest of Europe in art work, and excited a very reasonable fear that their productions would make a poor showing compared with those of France, excepting such as might be sent from the two Rhine provinces which have now become a part of Germany, but which still remain French in all their arts and industries, as well as in the tastes and habits of their people. The lesson taught them at Philadelphia has made a deeper impression upon the manufacturers of Germany than is commonly supposed, and that they will make a vigorous effort to improve their products and bring them up to the standard of nations with more of natural taste in art matters, is probable. This, however, cannot be done at once. We understand that, in reply to the French invitation, the German government inquired whether the proposed exhibition could not be postponed until 1880; but as no disposition was manifested to consider this proposition, Prince Bismarck intimated that no application would be made to the Reichstag for an appropriation. We think the Paris Exposition will follow too close upon the heels of the Centennial to be completely successful, and it is not impossible that the scheme will have to be modified in many essential particulars before it can be brought to a consummation.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Academy of Natural Sciences.

(Abstract of Meeting held Tuesday, Dec. 19.)

From the proceedings of above meeting, among other matters of interest presented, we note the following:

Mr. Joseph Willcox remarked that the two fine specimens of scapolite which were presented this evening by Mr. Vaux were found at a new locality for this mineral, in St. Lawrence County, New York; and that a specimen from the same locality had recently been received in this city which weighs about twenty-five pounds, and is probably the largest scapolite ever found.

He also referred to a specimen of quartz on the table, from the well-known locality of green quartz at Blue Hill, in Delaware County, Pa. This specimen had been exposed to the weather for a few weeks, and had lost nearly all its green color.

Mr. Willcox also stated that during the last eight years, whenever the Schuylkill River has been covered with ice, he observed that the water supplied by the city possessed a disagreeable odor and taste like chlorine. Large quantities of chloride of lime are daily used at Manayunk and on the Wissahickon for bleaching purposes, and the chlorine gas is liberated from it by the application of alum and sulphuric acid. A large portion of the chlorine gas subsequently escapes from the water, before it reaches Fairmount; but when the river is covered with ice this process of purification is retarded, and the offensive element is practically conveyed in a covered trough from the mills to the pumps that supply our city with water. He was not competent to state if chlorine in this condition is prejudicial to health. Being a powerful disinfectant, it may act as a preventive of disease that might be caused by the foul material that is carried in such abundance through the sewers into the Schuylkill, and which, on account of the ice, would otherwise be transported into our water-pipes in its original impurity.

Mr. Vaux added that nearly all the crystals of scapolite from the locality spoken of by Mr. Willcox are doubly terminated.

Mr. Meehan referred to the nodules or protuberances ob observed upon branches of trees. These burrs were usually considered to be galls, but he had suggested some time ago that they were probably of a fungoid nature. This opinion was not supported, however, by the microscopical observations of Professor Farlow on these growths, and he had therefore given the subject close attention recently with a view to determining their real nature. He referred to the general growth of wood, and stated that cells which are at one period unable to multiply, become at a later stage true generating cells. In certain cases woody particles are found in these cells which, not having vitality enough to produce branches, protrude these woody particles year after year in the form of layers of bark or of the outermost portion of the generative tissue of the last year. Instances of various forms of growth of this kind were descsibed and the process illustrated by means of a diagram. Various forms of eccentricity of wood-growth were believed to be due to a similar cause.

VALUABLE PAPERS, in Van Nostrand, Jan., 1877.

New Construction in Graphical Status. Henry T. Eddy, C. E., Ph.D.

Retaining Walls. E. Sherman Gould, C. E.

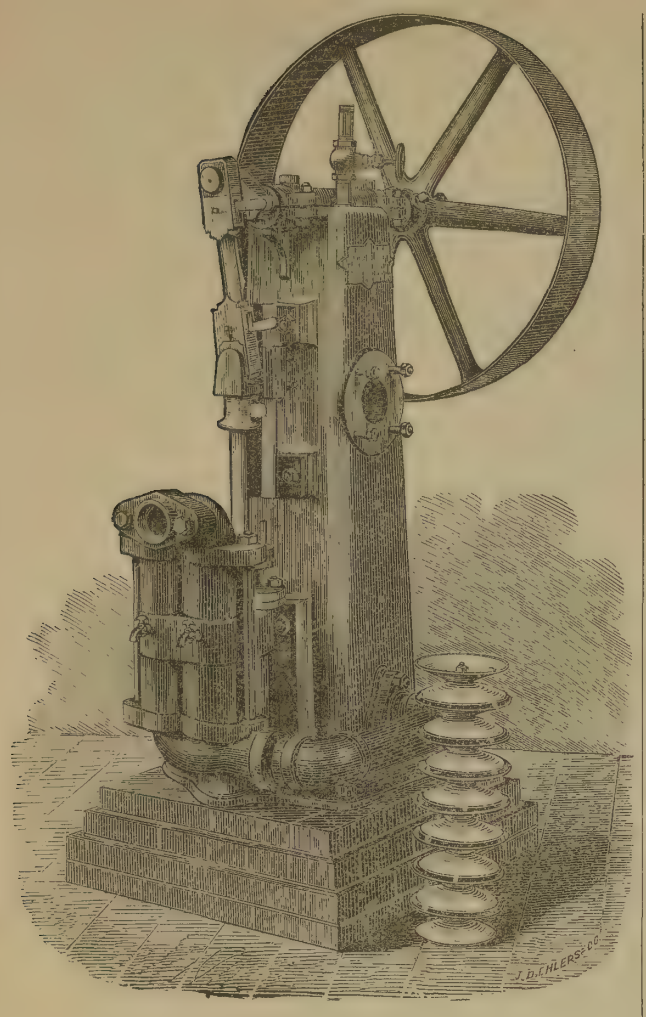
Force. De Volson Wood, C. E.

Note on the Most Economical Depth of Straight Girders and Trusses. Emil Adler, C. E.

Transmission of Power by Wire Ropes. A. W. Stahl, M. E., etc.

Irrigation in California. Frank Carpenter, C. E.

CENTENNIAL NOTES.



FEED WATER HEATER.

[Manufactured by Poole & Hunt, Baltimore, Maryland.]

"Unlike other heaters, into which the exhaust steam from the engine is first discharged and then permitted to escape, this heater is simply connected to a branch from the exhaust-pipe, in such a manner as that a portion of the exhaust steam is attracted into the heater in sufficient volume to raise the feed water to a temperature of 200° or more. The cold water is admitted into the heater in a small but continuous stream, and flows over and through a series of disks of appropriate shape, within the heater, (shown detatched, at the right of the heater box.)

The free escape of the exhaust steam in not impeded in the slightest degree, nor back pressure caused in the cylinder.

The condensation and refuse grease and other matter from the cylinder does not enter the heater, thus avoiding one of the gravest objections that has been urged against "Open Heaters," viz: That the grease, etc., from the cylinder is transferred to the boiler, injuring the boiler, causing foaming, etc.

Two descriptions of this Heater are manufactured—one of them with *two pumps*, to be used in localities where the feed water requires to be taken from a well, or point *lower* than the heater; and the other, with *one pump*, to be used in cases where the feed water can be supplied from a point *higher* than the heater.

The heaters having *one* pump are made with single-acting, and also with double-acting pumps; the latter being shown in the illustration.

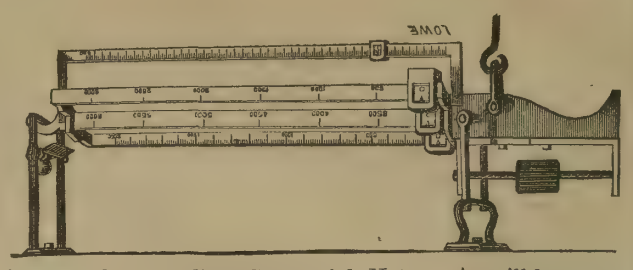
The combination of heater and pumps, arranged to be operated by a belt, is very convenient, not only as to the driving of the pumps, but as to their examination and adjustment while in motion."

THE CYNOPHERE.

M. Huret, of Paris, showed in the French section of the Main Building, a remarkable vehicle, illustrated herewith There are two large wheels, between which is a seat and a foot-rest; in front is a guide wheel controlled by a rod in the right hand of the driver (*sic!*); there is a brake operated by the left hand. Each of the side wheels (which are built lightly and strongly of metal), has a wire drum, or treadway, between its outer and inner set of spokes; and, as seen, the motive power consists of two dogs who run in the drums, as do white mice and squirrels in their familiar tread-mill cages.

COMPOUND SCALE BEAM.

The cut shows a very simple and convenient compound scale beam, made by the Buffalo Scale Co., and alluded to



in one of our earliest Centennial Notes. As will be seen, there are four beams, one graduated in pounds, as is customary, and the others graduated to whole and fractional *bushels* of corn, wheat, and oats, of a given number of pounds each.

INDUSTRIAL DEPARTMENT.

THE "LITTLE GIANT" ENGINE AND BOILER.

The discovery has long since been made that coal is cheaper than bread and beef, as a motive power; and the first application of steam for heavy pumping work, has been gradually but surely followed by its employment to execute tasks of lesser magnitude. Demand and supply for small motors have been mutually stimulated and progressive, and have been productive of increased efficiency and decreased first cost. One of the most marked results of this response to the demand for small, safe, and economical motors, requiring no special care or skill in running, is seen in the "Little Giant" Engine and Boiler, shown in the accompanying engravings, the patentee and maker being Ward B. Snyder, of 94 Fulton St., N. Y.

In Mr. Snyder's workshop, a one-horse engine is stated by a contemporary to be driving "two large lathes, a large vertical boring and drilling machine, a middle-sized planer, a grindstone, and an air-pump to compress air, used to transmit motion."*

This "one-horse" engine has a cylinder $2\frac{3}{4}\times4\frac{1}{2}$, making, with 60 lbs. steam, 300 strokes per minute.

The engine is horizontal, with a rectangular cast-iron bed-plate, to which the guides are bolted, and with which the housings for the crank-shaft journal-bearings are cast. The steam-chest is at the side, with lubricating tallow cup; the valve is of the plain D type, cutting off at $\frac{2}{3}$ stroke; the governor is of the ball style of throttling regulators, and is driven by a crossed round belt. The valve rod is peculiar, being of the *pendulum* style, substituting a single flexible stem for the ordinary stem and connecting-rod. The feed pump is a simple plunger at the side of the cylinder, and driven by an eccentric. The exhaust is used as a blower. All parts are fitted in such manner that lost motion may be taken up at any time, causing the engine to run accurately and smoothly. The cylinder is handsomely lagged with black walnut and ash; the base-plate, fly-wheel, etc., neatly painted. The boiler is of peculiar construction and has many meritorious features. It is seen in Fig. 2, removed

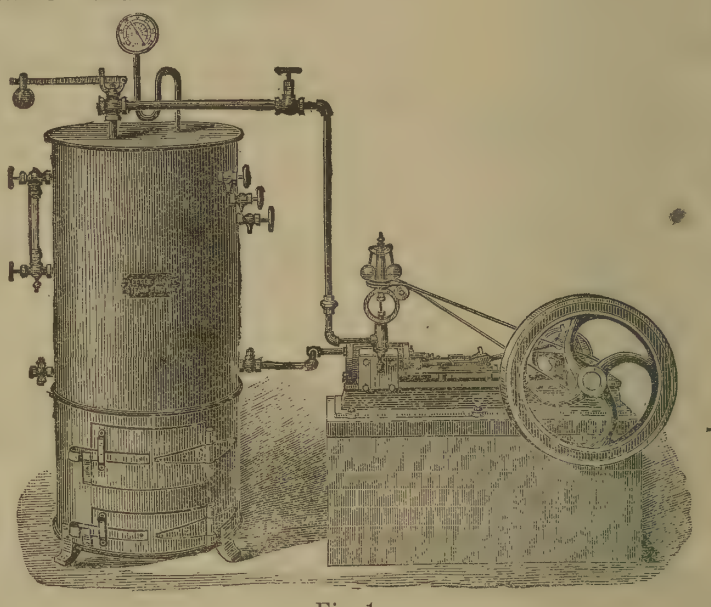


Fig. 1.

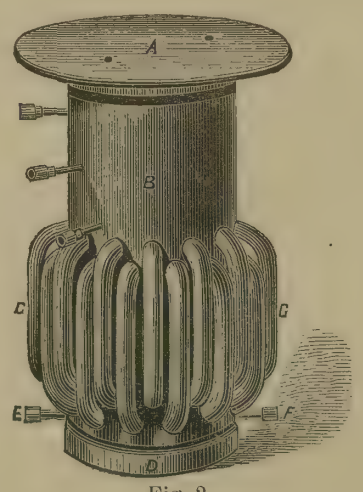


Fig. 2.

from its casing. It is formed of a lap-welded wrought-iron tube, B, screwed firmly into a cast-iron head-piece or cap, A, and a wrought-iron bottom plate, D. A number of lap-welded tubes, C, C, leave the main tube near the bottom, and re-enter it below the water-line; being well screwed from the inside before screwing on the boiler-heads.

The one-horse boiler has two feet of 10-inch lap-welded $\frac{3}{8}$ tubing, and 30 one and a-quarter foot tubes, $1\frac{1}{4}$ inch diameter; grate, 15 inches diameter. The two-horse boiler has $2\frac{1}{2}$ feet of 12-inch tube, $1\frac{1}{4}$ diam., and 40 two-foot tubes, $1\frac{1}{2}$ diam.; grate, 18 diam. The three-horse boiler has 3 ft. of 15-inch tube, and 50 ft. of $1\frac{1}{4}$-inch tube, each 3 feet long; grate, $22\frac{1}{2}$ inches diameter.

Each boiler is tested to 250 lbs. cold hydraulic pressure before leaving the shop. The ultimate strength of the 10″ tube in the one-horse boiler, is 1,000 lbs. per square inch.

The furnace is of iron, lined with fire brick. In accordance with the laws of some States, in regard to steam-boilers, there is a fusible plug in the bottom plate. It will thus be seen that the boiler has a high factor of safety from the most excessive steam pressure generated, from low water or any other cause. There is a safety-valve, which can be loaded to only 100 lbs.; also a steam-gauge, graduated to 100 lbs.; a blow-off cock, three try-cocks, and a glass water-gauge. The form of construction of the boiler is peculiarly applicable to small generators, from the possibility of employing lap-welded tubing throughout in the construction of their convex walls. It is of a type well adapted to the rapid generation and supply of steam. Facility of cleaning or repairs is also permitted; the unscrewing of either cap allowing of access to the entire boiler.

The boiler is admirably adapted for heating purposes, from its compactness, safcty, economy, and high generating capacity. These qualities should also commend it for steaming food; the one-horse size sufficing to steam enough for 100 head of cattle.

The smallest size consumes about as much wood or coal (either of which may be used) as an ordinary cooking stove; the largest size, about as much as a kitchen range.

The one-horse boiler has 17 square feet of direct heating surface, and —— of grate surface.

The one-horse engine and boiler occupy a space of 5×2 ft.; the two-horse, $5\frac{1}{2}\times2\frac{1}{2}$; the three horse, $6\frac{1}{2}\times2\frac{1}{2}$ ft. The cost of the one-horse engine and boiler is but $150; the 2 H. $200; the 3 H. $250.

The safety of the boiler, the simplicity of the engine, and the compactness, power and cheapness of the whole apparatus, should ensure for it a wide and profitable introduction and use.

**Manuf. and Builder*, vii, 271.

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